AMATEUR WORK

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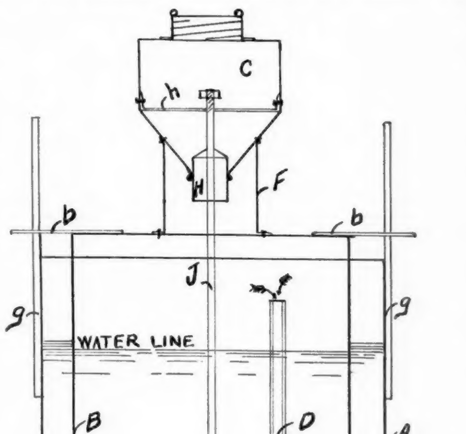
ACETYLENE GENERATOR

FOR MAGIC LANTERNS.

The acetylene generator here described is of ample capacity for providing sufficient gas for an evenings use of the magic lantern described in the previous number of this magazine. It is perfectly safe to operate, if the ordinary precautions attending the use of any illuminating gas are observed. Granulated carbide is used of about $\frac{1}{4}''$ screen. The pressure is easily regulated by weighting the bell *B* with rings of bar iron large enough to slip down over the carbide chamber *C*.

The tank *A* is made of fairly heavy galvanized or tinned iron, and is 18″ high and 15″ diameter. To the outer sides are soldered two pieces of $\frac{1}{4}''$ round iron rod *g* 12″ long, which serve as guides for the bell *B*. A piece of $\frac{1}{4}''$ iron pipe *D*, 22″ long is bent 16″ from one end, put through a hole punched in one side of the tank, and carefully soldered rigidly in position, where it passes through the tank and by means of a brace *d*, bent as shown and soldered to the bottom.

The main part of the gas bell *B* is also made of galvanized iron and is 15″ high and 12″ diameter. The top is a disk with a centre hole, 4″ diameter, cut through, and to the edges of which is soldered the tube *F*. The guides *D* of iron are also soldered to the top of bell, and are 5″ long, and 1″ wide; holes $\frac{3}{8}''$ diameter being punched 1″ from the ends for the rods *g*. Across the bottom a guide *f* for the plunger rod is fitted. It is made of hoop iron, 14″ long, and 1″ wide, 1″ at each end being turned up and riveted to the sides of the bell. The $\frac{5}{16}''$ hole should be in the exact centre. The guides *k* are fitted to the lower, outer edge of the bell, serving to keep it centered in the tank. The guides should be about $\frac{1}{8}''$ scant of meeting the sides of the tank. They



are made of strips of hoop iron 6″ long and 1″ wide bent to the shape shown and riveted to the bell, the lower end being riveted first and before bending.

The tube *F* is also made of galvanized iron and is 4″ diameter and 4″ high, the joints with both the bell and carbide chamber, *C* being strongly made and well soldered. The carbide chamber *C* likewise made of galvanized or tinned iron is much after the shape of an inverted oyster or milk can, only of larger size, and with a 3″ opening in the top fitted with a screw cover, similar to those used on preserve tins, which must be gas tight. This will undoubtedly have to be made up at a tin shop, but will not be expensive.

The bottom slopes inward at an angle of 50°, the hole in the centre making a close sliding fit to the plunger *H*, which is 1 ½″ diameter. A strap *h*, 8″ long and 1″ wide, with the ends turned up 1″, is fitted across the chamber as shown, a $\frac{5}{16}$″ hole in the exact centre acting as a guide for the plunger rod *J*. If possible, have the edge of the hole at *H* turned around a wire bail to give strength and stiffness. Certain forms of coffee tins fitted with screw tops, are obtainable in large cities, which could be cut down and fitted with the V shaped bottom, saving considerable work.

The plunger is made with a piece of ¼″ round iron rod, or cold drawn steel would be better, 24″ long. A thread for a nut is cut on the top end for about 2″. The part *H*, is made by first turning up a cylinder 2 ½″ long of hard wood, like birch or maple, with a pointed top to prevent the carbide from lodging there. Around the straight part of this wooden cylinder, fit a piece of tinned iron, the joint being a soldered butt joint, filed smooth after soldering to slide freely in the opening in the bottom of the carbide holder. When these parts are completed, put the plunger in place and see if it slides freely and accurately. The top of the straight part of *H* is about 2 ½″ from the upper end of the rod. The plunger should fit so that when pushed up against the strap *h* an opening of about ⅜″ is left between the bottom of *H* and the sides of the holder.

To the outer end of the feed pipe *D* is fitted an independent gas cock *M*, and just outside of this a straight pendant cock, to the outer end of which is fitted a male soldering nipple. The rubber gas tubing to the lantern is fitted over this nipple. Another piece of tubing is run to an adjacent window from the end of the independent cock, this being used to let off any excess of gas which might be generated by the dropping of considerable carbide. Should the plunger show any tendency to stick during operation and not close readily, bore holes in the wooden cylinder and run in moulten lead; the additional weight will prevent this, or the part *H* can be made of a solid piece of cold rolled steel shafting, a hole being drilled through the centre for the rod *J*.

The operation of the generator is as follows:—The tank is filled with water to a depth of about 12″, the bell placed in position, and held from dropping to the bottom of the tank by placing pieces of wood under the guides *D* and resting on the top of the tank. The cover of the carbide holder is removed, the required quantity of granulated carbide, ¼″ screen, placed in the holder; the cover immediately replaced and screwed firmly down; the sticks removed from under the guides thus allowing the bell to sink; the rod *J* resting on the bottom of the tank, causes the plunger *H* to open as the bell settles and a small quantity of carbide drops into the water; gas generates causing the bell to rise so that the plunger closes the opening in the bottom of the carbide holder, and the feed of carbide ceases until enough gas has been consumed to cause the bell to again drop low enough to again open the feed hole. When generation first begins, open the cock *M* to allow the air in the holder to escape, closing it when acetylene begins to flow. When through using, if the carbide is about used up, take into the open air and empty, using care that no lamp or other flame is near at hand. An electric hand-lamp is the best thing for such work.

A remarkable phenomenon is reported at St. Petersburg, from the rural commune of Schava, in the Government of Tsarey. Inexplicable noises were heard for several days issuing from the earth. The sounds varied from something like the booming of cannon to the screeching of steam whistles, and seemed to come from a forest skirting the commune. In this forest, where the terrified peasanty gathered in expectation of some great calamity, the earth was seen to heave incessantly. Gradually huge cracks appeared, the earth seemed to sink, water rose, and there came to view a new lake, of considerable extent, which is now being examined by geologists.

LANTERN SLIDE MAKING.

R. G. HARRIS.

I. Introduction—Slides by Contact.

The object of these chapters is to place before the slide worker a general review of the standard process for the production of slides, with descriptions of reduction and contact methods, and details of such accessories as may be deemed most useful to the general worker. For the benefit of those who have yet to make their preliminary trials in lantern slide work the subject will be treated *ab initio*, without assuming even an elementary knowledge of the process on the part of the beginner. Later on, processes will be described that appeal more directly to the advanced worker and to the lantern slide enthusiast; processes that are viewed by many simply with historical interest, and yet are capable of giving the finest results when facility in their working has been acquired. Albumen, collodio-bromide, wet collodion are processes that few modern slide makers connect with lantern transparencies, yet for downright quality no modern process can claim superiority over the time honored albumen, and slides of Ferrier's of thirty years ago hold their own when compared with the best work of today. Wet collodion, in capable hands, is still the process *par excellence* for obtaining crisp, bright results with a minimum expenditure of time and trouble, and collodio-bromide has the merit of having fixed a standard of excellence for the modern gelatine lantern plate.

A question the beginner in lantern-slide work will most probably ask himself is, "What constitutes a lantern-slide?" He is, most probably, already in possession of the fact that, in the negative he has taken, the lights and shadows of the original are reversed and that to obtain them as they existed in the original it is necessary to get from the negative a print which gives the lights and shadows of the original as they were seen by the eye. This "positive" print on paper will be viewed by "reflected" light, i. e., by light reflected to the eye from its surface. If the gelatine film of a P. O. P. print was stripped from its paper support the "positive" image would be seen to exist in this film, but as there was no longer any white background paper to reflect the light through this image it could not be seen as a positive. Suppose this film was now laid upon a clean piece of glass and pressed firmly and evenly into contact with it, on being held up between the eye and a clear view of the sky the positive appearance would be restored and the picture would again be seen as plainly as when it was supported on the white paper. The film, in fact, has now become a lantern slide, but instead of being made apparent to the eye by light *reflected from* the white paper support, the eye sees the picture by light *transmitted through* the film from the background of the sky. It will be obvious, then, that fundamentally there is no difference between the paper print and the lantern slide, but that the one is, for convenience, placed upon a white paper support while the necessity for using transmitted light in the optical lantern demands that for a lantern slide the image bearing film be borne upon a transparent support.

It follows from what has been said that lantern slides can be printed from the negative in just the same way as an ordinary silver print, provided that the same sensitive material is used upon glass instead of upon paper; the image could afterwards be toned and fixed as though it were a paper print. At one time, considerable lantern slide work was done in this manner, as the image becoming visible during printing, offered facilities for modifying it not available when the image required developing. The inconvenience of using an inflexible support in the printing frame, which prevents a ready view being obtained of the depth of the print, coupled with the slowness of the process, debarred it from attaining any permanent popularity. At the present time lantern slides are produced almost exclusively on the lantern plates of commerce.

The exposure of a lantern plate may be either

by "contact" or by "reduction." Suppose the worker employes a quarter plate hand camera for taking the negatives, he can make his lantern slides by placing the negatives in the printing frame as used for paper, adjusting his lantern plate upon the negative, film to film, closing the frame and exposing to gas light for the necessary time. In this case he is working by "contact" and as the size of a lantern is 3 ¼″ x 4″, while the quarter plate is 4 ¼″ x 3 ¼″ it follows that, when working by "contact" some portion of the original negative has to be omitted.

It is frequently the case that when working from hand camera negatives some portion of the original negative can be omitted without detracting from the value of the picture, but where larger sized plates are used, half plates and upwards, contact printing is out of the question unless some very small portion of the original is desired. When it is desirable to make lantern slides from negatives which are of much greater dimensions than the lantern plate the slides are got by reducing the original size of the negative, by means of the camera, until it shows on the focussing screen the same size as the lantern plate. A lantern plate being placed in the dark slide and exposed to this image will result in a lantern slide that embraces the whole of the subject that is in the larger negative. This constitutes the method of work known as "reduction." Later on full description of these two methods of working will be given, with the apparatus necessary in each case.

Some workers of experience contend that finer results are got when making slides by reduction, even in the case of quarter plate negatives. I am inclined to think that such is the case, though the gain in quality is not sufficiently striking to impress a beginner.

One decided advantage camera reduction has over contact printing is that, should any unevenness be present in the surface of either negative or lantern plate, the definition is not impaired. "Contact" printing is certainly the simplest form of exposure for the beginner, and as it can be conducted without any special apparatus, as it is entirely independent of daylight and with some lantern plates, even of the customary dark room, it is the method that will receive the first consideration in these chapters.

Before commencing any description of the methods whereby lantern slides are made, it may be well to caution the beginner against depriving himself of sufficient light in the dark room. The sensitiveness of lantern plates is so greatly inferior to that of plates used for negatives that it will take the beginner in lantern slide work some time before he acquires the courage to use all the the light permissible with these slow plates. Some lantern plates are so slow that they can be manipulated in the light of a naked bat's wing burner, if it be turned down, and the plates are not exposed unnecessarily to its light. With the ordinary lantern plate, made for reduction and contact work, the light of a parafine lamp screened by two thicknesses of canary medium will give a light that is both safe and comfortable. It is convenient to have between the fabric and the lamp burner a sheet of finely ground glass which affords a very pleasant diffused light whereby to judge the density of the slide. It is convenient also, on taking the slide from the fixing bath to raise the cherry colored fabric and have the greyed surface to examine the slide by.

The negative for contact printing, which will probably be of quarter plate size can be placed in a quarter plate frame such as is used for paper printing; it is carefully dusted with a broad camel hair brush to remove anything that might injure the film of the lantern plate. This latter is then placed upon the negative, the film of the lantern plate against the film of the negative. The lantern plate should not be slid into position over the surface of the negative or damage to the film may result; it should be placed deftly into the position it has to occupy without any need of readjustment when laid down. The back of the frame should be placed in position and fastened by the springs. It must be remembered that the thickness of the lantern plate will cause considerable pressure if the felt pad used in paper printing is employed here also, and usually quite enough pressure to insure contact will be got without using the pads.

Having fixed the lantern plate in the frame it now requires exposing to light. Daylight is practically out of the question, as in spite of the relative slowness of these plates, they are still sufficiently rapid to make daylight exposures un-

manageable. The most convenient light is a gas burner, and if it has a bypass, exposures can be readily made in the dark room without loss of time. We must bear in mind the fact that in lantern slide work long exposures give warm colored slides (the developer being suitably adjusted) and short exposures black tones. Suppose five seconds' exposure at a given distance from a bat's wing burner gives a lantern slide of black tone, then with half a minute's exposure at the same distance the slide will have a brown color, and with a minute's exposure the color will be decidedly red. The developer would require modifying in each case to suit the increased exposure. Producing satisfactory warm tones in lantern slides, at the same time retaining other desirable qualities, demands more experience than making a slide having a black color, and such being the case, the beginner is recommended to adhere to the production of black colored slides until he can make them with ease and certainity.

A negative of medium density, held about eighteen inches from a bat's wing burner would require an exposure of some six seconds for black colors, when the ordinary lantern plate was used, and developed with the formula given below :

Amidol	20 grains
Sodium sulphite	240 grains
Potassium bromide	10 grains
Water	10 ounces

Development is very rapid, much more rapid than would be the case with a negative, and the beginner has to be on his guard against obtaining excessive density. The exposure must be so timed that when development is complete, the highest lights of the picture have no veil over them, this can readily be seen after the plate has been fixed if the slide be laid upon a sheet of white paper. The paper should show through the high lights perfectly white, otherwise a crisp picture, when the slide is projected upon the sheet, cannot be hoped for. As soon as density has been obtained in the developer the slide is placed in the fixing bath, made as follows:

Sodium hyposulphite	2 ounces
Sodium bisulphite	½ ounce
Water	10 ounces

This is a brief description of the making of a lantern slide, and the beginner is recommended to persevere with the above simple method until he can produce slides of good quality.

Photography.

CHEMICALLY COLORED LANTERN SLIDES.

Mrs. C. R. MILLER.

Over a year ago, *Western Camera Notes* published the following formula for the toning of lantern slides, that is, giving a wide range of tones in brown, red, blue and green.

Brown and red tones.

A.	Uranium Nitrate	40 grains
	Water	1 ounce
	Acetic Acid	20 drops
B.	Potassium Ferricyanide	25 grains
	Water	1 ounce

To 6 drams of water add 1 dram each of A and B. When toned to the desired color wash in slightly acidulated water until the greasy appearance is gone. It must be borne in mind that this bath intensifies the slide, which should therefore be made somewhat thinner than desired.

Blue Tones: The red tone obtained by the Uranium bath may be changed to greenish blue by immersion in the following bath:

Ferric Chloride	5 grains
Water	6 to 10 ounces

A slightly greener tone is obtained by the use of the following bath:

Iron Protosulphate	20 grains
Cold water	1 ounce
Sulphuric Acid	1 drop

The following will give blue tones:

A.	Ammonio Citrate of Iron	4 grains
	Water	1 ounce
B.	Potassium Firricynade	4 grains
	Water	1 ounce

When dissolved, add A and B and then add Nitric Acid 10 per cent solution 5 drops. After toning wash in a gentle stream of water to clear the "white."

To my mind this should have at least created some comment among lantern slide workers. Yet after waiting patiently for nearly a year I have read of none who have tried this most excellent method of relieving the monotony of black and white slides.

It takes an artist of steady nerve and rare ability to tint a lantern slide which will not prove a freak when shown upon the screen. As few of us can lay claim to such talent, the next best thing to do is to find some way of making them attractive by chemical toning. A few days after the magazine arrived I brought out some weak slides which has been thrown aside to be washed for cover glasses. I mixed up the Uranium and Ferricyanide toner and after thoroughly soaking the slide in water, I placed it in the chemical tray. In a few minutes the effect was like magic. The old faded-looking plate came out of its bath a rich red brown. After washing thoroughly, and care must be taken to do this properly, the slide was dried and thrown upon the screen. It seemed to me that detail which never showed in the photograph appeared upon the canvas. Delighted with its success, I later tried the other formula above mentioned with the same good effect so much desired for lantern slides.

I called in my photographic friends and they all agreed the effect was beautiful. Several of these are now using the same chemicals in like manner. Care must be taken not to allow the toner to settle in spots on the plate and it is best to do one at a time and keep it moving. Then, too, remember to soak the slide well before placing it in the coloring tray, otherwise the chemicals will not attack the coating evenly and a freak slide will be the result. Be sure to keep your chemicals in a dry place, especially the Ferric Chloride, which, if exposed to moisture any length of time before mixing becomes valueless. Glass stoppered bottles should be used for all.

The beginner must be prepared to spoil a number of slides, but the result after a few trials will prove highly satisfactory. I have been interested in lantern slide work for a number of years and have between six and seven hundred. It has been my pleasure to try many ways of coloring and various toners, but the formulas reproduced above is by far the best of them all. The slides have been tried under all sorts of light, coal oil, gas, calcium and electricity and the coloring out with equally beautiful effect. I have more than one hundred views of the picturesque parts of Colorado toned in this manner. The chemicals have been so manipulated as to reproduce the exact shade of the wonderful Rocky Mountains. Occasionally a freak slide will result from improper washing or a mixture of chemicals. Yet they even are not always lost. Some of them are really very pretty, giving the effect of double staining.

It has been suggested to me that "whatever intensifies will also fade." That may or may not be true. My slides have been exposed to strong light and not a little dampness, yet they are as fresh as the day they were made. I cannot see why they should change color or fade out, and I do not believe they will. However, should such be the result, I would remake the entire lot using the same toners.

The plates to be colored by the method of which I have spoken may be of any good make, and developed with the developer which pleases the photographer. The chemicals work equally well on all brands of plates. After all, the real joy of amateur photography is in lantern slide work. Magic lanterns are cheap and easily rigged up in a private house. You may show your pictures with good effect to your friends, and if you are any sort of a talker (amateur photographers generally acquire that habit) you may add to your income by appearing at church and school entertainments and in this way make your art, whose only fault is expense, pay for itself. If you do not care to be reimbursed for your work, you will be all the more popular and "'twere good you do so much for charity." To successfully give an evening's entertainment the slides must have merit, show good detail and be made attractive by some little coloring.

Western Camera Notes.

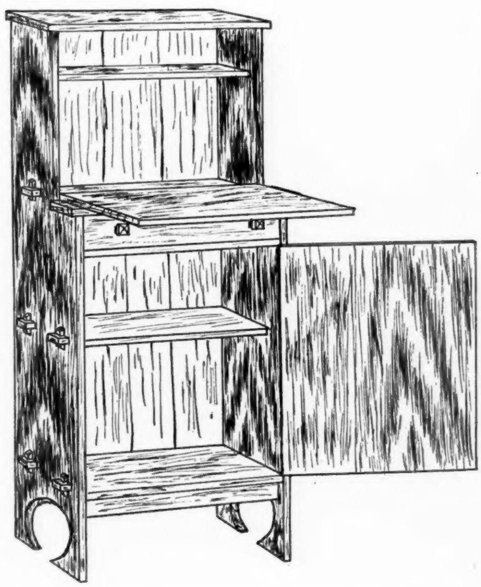
BATH-ROOM CABINET.

JOHN F. ADAMS.

As the bath rooms of modern houses are seldom provided with cupboards wherein medicines and toilet articles may be kept, the cabinet here described will be found a most convenient piece of furniture for such uses. The wood used for making it should be that which will most nearly match the finish of the room, unless a decided contrast is desired, in which case, oak with weathered oak stain gives a good effect.

As shown in the illustration, the shelves have tongues projecting through the side pieces, with wooden pins placed in holes cut therein, but the cabinet can be made without them, grooves being cut in the side pieces for holding the ends of the shelves. The stock used should be ¾″ or ⅞″ thick, the curved cuts at the foot of the side pieces being made at the mill where the stock is purchased, and are 5″ high and 8″ wide at greatest diameter.

The side pieces are 45″ long and 15″ wide. A piece 5″ wide and 16″ long is cut out of the front of the ends forming the upper part. The top and shelves, excepting the one in the upper part, are 24″ long over all, the top being 13″ wide the, shelf in the lower part 12″ wide, and the bottom board of the lower cupboard, 15″ wide. The under back edge of the top piece, and the upper back edge of the bottom piece have ½″ rabbets cut therein for the ½″ sheathing at the back. Two pieces 2″ wide and 21 ¼″ long, are needed, one under the bottom of the cupboard at the front, and the other forming the front edge of a rectangular frame under the drawer. The shelf for the upper cupboard is 22 ¼″ long and 10 ⅝″ wide, the front edge forming a stop for the drop lid. A groove for this shelf ½″ deep is cut in the side pieces, 4″ from the top ends of the letter. All the shelves are set ½″ in from the back edge of the side pieces to give space for the ½″ sheathing of the back. The shelf above the drawer has only one tongue on each end projecting through the side piece, the front edge forming a projecting at each end 4″ wide, the inner edge meeting the front edge of side piece. The drawer is 4″ deep, requiring for the front a piece 21 ¼″ long and 4″ wide, two side pieces of white wood ½″ thick, 4″ wide and 14 ½″ long, and a cross piece at the back 21 ¼″ long, 3 ⅞″ wide, and ¾″ thick. Rabbet the ends of the front and back pieces to receive the ends of the side pieces, and the lower edges of all the pieces to receive the bottom board 20 ¾″ long, 14″ wide and ¼″ thick. The frame to support the drawer is made of pieces 2″ wide, the ends being halved, except that for the front piece which is not cut clear through to the front edge.



The tongues projecting through the side pieces are 1 ⅞″ long and 2″ wide, the holes for the pegs being ⅝″ square. The outer edges of the tongues are 3″ from either edges of the side pieces. It will be best to cut the holes first and then locate and cut the tongues. The pegs are 2″ long. The lower holes are 6″ from the floor, those for the shelf above, 17″ from floor ; the hole

for the shelf above the drawer lines with the cut previously mentioned. The drop lid for the upper part is 21 ¼″ long and 15 ⅛″ wide. To keep this from warping, rabbet the inner edges of the ends and glue on strips 2″ wide and ½″ thick, which are not shown in the illustration. If perfectly dry stock is obtainable, and same planed on a jointer to take out the wind, these strips can be omitted. The hinges are hung on the lower edge, and do not show. A spring catch at the top keeps the lid closed.

The door for the lower part is 17 ¼″ high and 21 ¼″ wide, the grain running vertically, consequently it will have to be glued up from two pieces. It is hung with hinges suitable to the wood used and finish, hooks for hot water bottle, etc., being placed near the top on the inside. Suitable catches are fitted, and locks also are desirable if small children are likely to make tests of the medicines there stored.

MICROSCOPY FOR AMATEURS.

S. E. Dowdy. M. P. S.

IV. Testing the High Power Lens.

Microscope lenses are subject to three principal defects. They may show spherical aberration, chromatic aberration, or want of flatness of field. For the causes and means of remedying these faults the student should read up an elementary book on optics, as it is only misleading to attempt to explain the why and wherefore of these characteristics of a defective lens in a few words. They are due, if present in an objective, to faulty workmanship, and should, therefore, act as danger signals, warning a prospective purchaser from acquiring the lens in question. I am, of course, referring to what are generally known as "achromatic" lenses, such as are in general use, and not to the recently introduced series of lenses known as "apochromatics," the outstanding corrections of which are made by special compensating eyepieces. The presence of marked spherical aberration in an objective would be shown by the impossibility of getting a perfectly sharp image of an object, the margins of which would apparently be hazy, even when the lens should apparently be in focus. Chromatic aberration makes its presence known by imparting a halo or colored fringe to the outlines of an object seen through any lens possessing this undesirable property. Flatness of field is present if objects lying in the same plane are in sharp focus, in whatever portion of the field of view they may be. For instance, if we were looking at a piece of paper with very minute printed matter upon it, using, say a 1 inch lens and a low-power eyepiece, and the print in the centre of the field was a sharp focus, that at the edges should also be so without altering the focus; otherwise the lens does not possess a flat field, which is an important desideratum in a low-power lens. Owing to vastly improved methods of manufacture, both English and Continental makers are now supplying students with well-corrected lenses at a low price. Glaring defects are, therefore, not often to be met with, and the student is hardly likely to meet with good examples of either chromatic or spherical aberration when testing his lenses, provided they are by a maker who has a reputation to maintain. Still, lenses constructed from even the same formula will vary to a certain extent, so that it is as well that the beginner should have a general idea of how a lens may be tested. If really interested in this branch of the subject, he should obtain two or three uncorrected lenses, of varying convexity, which, with the help of the aforementioned book on optics, can be made the groundwork for several very instructive experiments bearing on spherical and chromatic aberration. After a few such experiments with stops and diaphragms of various kinds, he will better understand the value of the aperture and other important parts of his objectives.

We now come to what, for the beginner, will prove a slightly more difficult matter, viz., the testing of his high-power lens. For simplicity's

sake I assumed that in testing the low-power lens, the student dispensed with the use of a substage condenser. It is impossible, however, to fairly test a high-power lens with such an inadequate illumination as that obtained by using the mirror alone. A few words, therefore, as to the method of obtaining suitable illumination with the condenser will be necessary. Most substage condensers supplied with students' instruments are what are known as Abbe illuminators, or Abbe chromatic condensers, to distinguish them from the Abbe achromatic condensers, which have carefully corrected lenses.

As the student will have no difficulty in understanding, condensers are subject to the same defects as objectives. They may, and usually do, possess both spherical and chromatic aberration, but whereas these properties in a lens would be quite sufficient to immediately condemn it, much useful work may be done with an Abbe chromatic condenser of the useful student's type, in spite of their presence. For the finest results in high-power critical work, microscopists use condensers achromatised, possessing what are termed large aplanatic apertures, but it requires a trained observer to mark their superiority over the less pretentious substitute supplied with student's instruments. When the beginner is in a position to appreciate this undisputed superiority, it will be time for him to think of exchanging his uncorrected Abbe for one of a higher type.

To return, however, to our main project, the testing of our high-power lens, which will most probably be either a $\frac{1}{4}''$ or $\frac{1}{6}''$. In the first place, to give the objective a fair trial, good illumination must be first secured, then a suitable test object placed on the stage, proper focussing effected, and allowance made for thickness of cover-glass surmounting the specimen. The tube length employed must also be the one for which the lens was corrected.

The necessary information as to thickness of cover-glass and tube length will, as a rule, be found in the maker's catalogue, or else furnished on application; and, if possible, the test should be made complying with these conditions. The better-class high-power dry lenses are furnished with a small adjustment, called a correction-collar, to allow for varying thicknesses of covers; but a similar result can be obtained by the student by slightly altering the length of the draw-tube.

To secure suitable illumination, the low-power lens should be first on the instrument, and the low power eyepiece used with it. The small paraffin lamp is placed on the left side of the observer, and light from it is flashed up by the mirror. A fine ground-glass slide is now placed on the stage, and focussed with the objective. The lamp flame is now turned edge on to the mirror and the condenser is racked up until an image of the flame appears sharply defined on the ground glass. If this image is not exactly in the centre of the field, it must be made so, either by using the centering screws with which most condensers are fitted, or else by slightly altering the position of the mirror or lamp.

We now have what is known as critical illumination, and the object to be viewed is brought into this brilliant image of the lamp flame after first removing the ground glass slide. As only a very small portion of the field is thus illuminated, this method is only suitable for testing resolving power and definition of the lens. The beginner had better, therefore, first obtain this critical illumination, and then rotate the lamp till its flame is broadside on to the mirror. The condenser should then be slightly racked down out of focus until the whole field is brilliantly illuminated. Now remove the eyepiece and look down the body tube and see how much light is entering the objective. To get good results, the back-lens should appear about two-thirds full of solid cone of light, and this must be obtained either by opening or closing the iris diaphragm, or placing a smaller or larger stop in the condenser. If possible, the condenser should be fitted with an iris diaphragm, which consists of a series of thin metal plates so arranged that by moving a lever they can be made to open or close up to give any desired aperture.

We can now replace our eyepiece, and a good illumination for testing the general value of a lens will be obtained. The very finest definition is theoretically and practically obtained by easing the edge of the lamp-flame, viz., critical light, but for the beginner's purpose a fully illuminated field will be preferable. I might mention here that if the low-power objective is being used the condenser will enhance its performance. In this case, however, the top lens of condenser must be

taken off, and, if possible, a circle of ground glass be placed in the stop carrier with which a condenser is usually furnished, so as to moderate the light. To return to our $\frac{1}{4}''$ or $\frac{1}{6}''$ lens, however, we shall now require a test object. The silicious valves of a species of organisms known as diatoms are generally employed for this purpose. These valves are mostly marked with a series of very fine, what will probably appear to the beginner as lines, but which under proper conditions assume more the appearance of short strings of beads or dots. The capability of the lens to show these markings as separate dots constitutes its resolving power, which is slightly dependent upon its aperture. In *skilled hands*, therefore, these tests objects are most useful indicators of the value of the lens being used; but as a knowledge of the nature and physical characteristics of the object itself, and also the best methods of illuminating it to bring out these details, is essential to success, it would be better for the tiro to pick out an easier object. If, however, he can obtain what is called a spread slide of mixed diatoms, he could use it to advantage in the following way. Having placed it on the microscope stage, he should first of all select a medium sized diatom under the low power, and bring it quite in the centre of the field. He should then substitute the higher power, focus it carefully, and see if the markings upon the diatom valve are shown in fine lines under a low-power eyepiece. If this is the case, the diatom will most likely be a suitable one for testing the lens, because on subtituting the higher power eyepiece, and manipulating the mirror so as to obtain oblique light, these lines may be split up into strings of pearls or beads. This result will depend entirely on the aperture of the lens, its perfection, and the skill of the observer in obtaining correct illumination. As the fineness of these markings differs considerably, even in the valves of the same kind of diatom, it follows that such a test must be a comparative one. Suppose, for instance, the observer can obtain the loan of a really good lens of *similar aperture* to his own, and can try comparison tests with his own lens on the same diatom, it will afford him a pretty good guide as to the capabilities of the one he has purchased. In passing I might mention that to obviate the variability in the fineness of the markings on diatom valves, test slides are often substituted artifically ruled with lines of such extreme closeness and exactness of individual distance apart that it requires very high magnification and big apertures to show them as separate lines. These slides, however, are beyond the province of the beginner, but are interesting examples of human skill and ingenuity. To turn, however, to an object that can be judged with greater facility. Such a one would be found in the object used for testing the 1″ objective, viz., the wing of the housefly. It must be viewed with critical illumination, using both low and high-power eye-pieces, noting carefully the appearance of the fine hairs fringing the edge of the wing. These should stand out sharp and clear, free from haze and color. Flatness of field, which, however, is not such an important property in a high-power lens as it is in one of the longer focal length, can be judged by racking down the condenser until the whole field is full of light, and then noting the sharpness of definition of the wing membrane at the sides of the field as compared with that in the centre. In using high powers an approximate focus should be obtained with the coarse adjustment, critical sharpness of image being obtained by using the fine adjustment without removing the eye from the eyepiece. Light rotation between finger and thumb of the milled head of the fine adjustment is all that should be nceessary to impart a smooth, low movement, with freedom from lateral displacement of the image. A good general test object for our high-power lens, and one easily obtainable, is a drop of fresh blood. This can be easily obtained by tying a handkerchief tightly round the forefinger, which should first of all be held downwards for a short time, and then pricking the tip of the finger with a perfectly clean fine needle. In pressing the finger, a minute drop of bood will exude, and this is transferred to a slide as follows:— A thin clean 3″ x 1″ slide is placed on a piece of notepaper, and a thin cover-glass is put on its centre. The blood-drop is then touched against the edge of the cover-glass, when capillary attraction sets in, and a thin film of the liquid is drawn under, and is then ready for examination. When viewed with a $\frac{1}{4}''$ or $\frac{1}{6}''$ lens, human blood is seen to consist of numerous rounded biconcave corpuscles floating about in a colorless liquid. On closer

examination a few larger colorless or greyish corpuscles will be seen, these being the so-called white, the others the so-called red corpuscles of the blood. The sharpness of outline of the margins of the red corpnscles should be carefully noted, and a general view of the field taken before arriving at any conclusions as to the value of the lens.

BOOKS RECEIVED.

Introductory Course in Mechanical Drawing, J. C. Tracy, C. E. and E. H. Lockwood, M. E., American Book Co., Boston, 155 pp. 10 ½ x 7 ½ Inches, $1.80.

While there are many instruction books upon this subject, an examination of this one shows that the method of treatment is both novel and interesting, and in every way calculated to rapidly advance the student to a thorough knowledge of the principles of mechanical drawing, orthographic projection and perspective. The feature which at once attracts attention is the extensive use of photographic illustrations of models, which so clearly present the several lessons, as to place this book in a class by itself. It is decidedly the book for beginners, and the student who will study it faithfully, will find progress easy, rapid and thorough, and upon its completion, well prepared to persue advanced work in such special lines as may seem best. Teachers in mechanical drawing will find the book of great assistance in giving an added interest to class-work. It is printed on extra heavy plate paper, with 163 illustrations and eight large plates.

A Brief Course in General Physics, George A. Hoadley, A. M., C. E., American Book Co., Boston, 463 pp. 7 ½ x 5 Inches, $1. 50.

The aim of the author has been to present the different phases of the subject in a logical manner, with an adequate number of experiments, and yet have the work completed within one academic year. The latter qualification would ordinarily mean that much desirable matter be omitted, but a perusal of the book shows it to be exceptionally comprehensive, and containing experimental work of the most modern type. A feat ure which will be greatly appreciated in many schools is, that only comparatively simple forms of apparatus are required for the experimental work. Proper attention has also been given to the mechanical principles underlying the subject, thus realizing one of the important advantages derived from its study. An appendix gives additional work, for the benefit of those wishing to meet university entrance examinations, to the 257 experiments given in the regular work.

First Lessons in Wood Working, Alfred G. Compton, American Book Co., Boston, 188 pp. 7 x 5 Inches, 80 cents.

The author states that the work given in this book is designed for young pupils, say between the ages of eleven and fourteen, but as the larger portion of three chapters is given to making a panel door with mortised joints, the professional wood-worker who might read the book would be rather skeptical of finding many young people of that age who could handle tools well enough to do even a passable job of the kind. There are many other studies in simple wood-working, requiring less material and fully as instructive, which would be preferable to that mentioned, but we can perhaps excuse this in view of the fact that the balance of the book has good, usable work, which is well presented. The illustrations are 84 in number.

HANDY RECEIPTS.

CEMENT FOR GLASS AND METAL.

An excellent cement for uniting glass to metal is made as follows: — Pure gum arabic is soaked in a small quantity of water for 12 hours and will then be of about the consistency of molasses. Calomell (mercurous chloride or subchloride of mercury) is then added in sufficient quantity to make a sticky mass, stiring well to get a thorough mixture. It will harden, after applying, in a few hours so only enough should be made than is required for immediate use.

HARNESS DRESSING.

Myrtle wax, 2 lbs; beeswax, 2 lbs; tallow, 2 lbs; lamp black, 1 oz; castor oil, 2 pints; neatsfoot oil, 1 gal. Mix well by aid of gentle heat, and always mix thoroughly before using. The harness should be well cleaned before applying any kind of dressing. It is best to wash the leather with soap suds, and then dry with a cloth, before using the dressing.

AMMONIA SOAP.

A soap made as follows as a cloth cleaner or grease eradicator is recommended: — Mix together 50 c. c. oleic acid; 25 c. c. ether; 25 c. c. chloroform; 250 c. c. benzine; and 50 c. c. spirit ammonia, in the order given, with occasional shaking. If a white emulsion is preferred, the same or double the quantity of ammonia water, may be substituted for the spirit, the excess of alkili in this case being rather an advantage.

MACHINE DRAWING. III.

Pulleys, gears, cranks, and other pieces are fastened to shafts by means of keys, the usual form being shown in Fig. 14. Keys, in their several forms, prevent the piece from turning other than with the shaft, and to some extent offer resistance to lateral movement along the shaft. For light pulleys, and pieces carrying only a small load, the *saddle key* shown in Fig. 15, may be used. As it conforms to the shape of the shaft, friction only prevents movement on the shaft. It is much used for temporary fastenings, where cutting the shaft is objectionable. The *flat* key shown at *B*, Fig. 15 is more secure than the other, yet requires but little metal to be removed from the shaft. The *sunk* keys shown at *C*, Fig. 15, is the one used for permanent fastenings, and is much the strongest and most satisfactory of the three. It fits a slot cut in both shaft and piece, has a slight taper so as to hold firmly when in place, yet admitting removal without difficulty, when necessary.

A taper pin, sometimes used in place of a key, is shown in *D* Fig. 15. Its more particular use is that of fastening cranks to their shafts.

A cotter is a tapering bar used for connecting two pieces, in such a way as to resist tension. A simple form is that shown at *A*, Fig. 16; the cotter resists tension while the collar on the rod also resists thrust. The form shown at *B* resists tension only, but has gib ends to prevent movement from place. A divided cotter is shown at *C*; the upper part should be shown with overlapping ends and is called a gib; the other is a plain cotter. An ordinary foundation bolt with iron washer is shown at *D*, Fig. 16, the gib ends keeping the cotter in place. Cotters are often used to connect two rods by means of overlapping straps as shownin Fig . 17. When, owing to vibration or other causes, it becomes necessary to ensure that the cotter will be securely fastened, an arrangement of gib and cotter is used as shown in Fig. 18, the gib having shoulders and the cotter, which passes through the gib, fastened with a screw-bolt.

One view of a knuckle is shown in Fig. 19; these being used to connect rods which, for various reasons, cannot be fitted with a rigid joint. An adjustable joint is shown in Fig. 22, each end of the long nut being threaded, one end with a right hand thread and the other with a left hand thread. The central portion is without threads and enlarged to clear the ends of the rods. The outside is usually hexagonal, to which wrenches are applied for adjusting.

A flange coupling is shown in Fig. 20, each flange being keyed to the shaft with a sunk key. A hanger for shafting is shown in Fig. 21, one half giving a front view and the other half a cross section view. This is a common method for drafting any piece which is alike on both sides, a considerable saving in time and number of drawings being affected thereby. It must be understood by the reader that the exercises given in this series are but a few of the many forms of devices in use, but they well serve to give a general idea, which the reader can study in greater detail as occasion may require. The studies in Fig. 16 are sectioned and shaded to show the greater clearness given to drawings by such work.

The latest record broken is in the ballooning line, and a message from Berne informs us that a balloon has reached the enormous attitude of almost 11 ¼ miles. This is an improvement on the first notable ascent, 120 years ago, when 1, 500 ft. was the height attained. This Swiss balloon, of course, carried no human cargo, but only self-registering instruments. These showed that the greatest cold experienced was 58° below zero. Men have managed to ascend to an altitude of seven miles, but their condition was fraught with great danger. Perhaps in the future some contrivance, in the shape of a closed car, may be invented, which will permit of much loftier ascents; but there seems hardly sufficient inducement to warrant the risk.

Steam Generation, says *Cassier's Magazine*, is the result of several processes which are carried out with a boiler or generator of suitable design. These processes are (1) combustion, which means the combination of the oxygen of the air with the carbon, hydro- carbons, and hydrogen of coal or other fuel at a suitable temperature; (2) transmission of heat; (3) change of the physical state of the water in the boiler, in which is involved the phenomenon of latent heat.

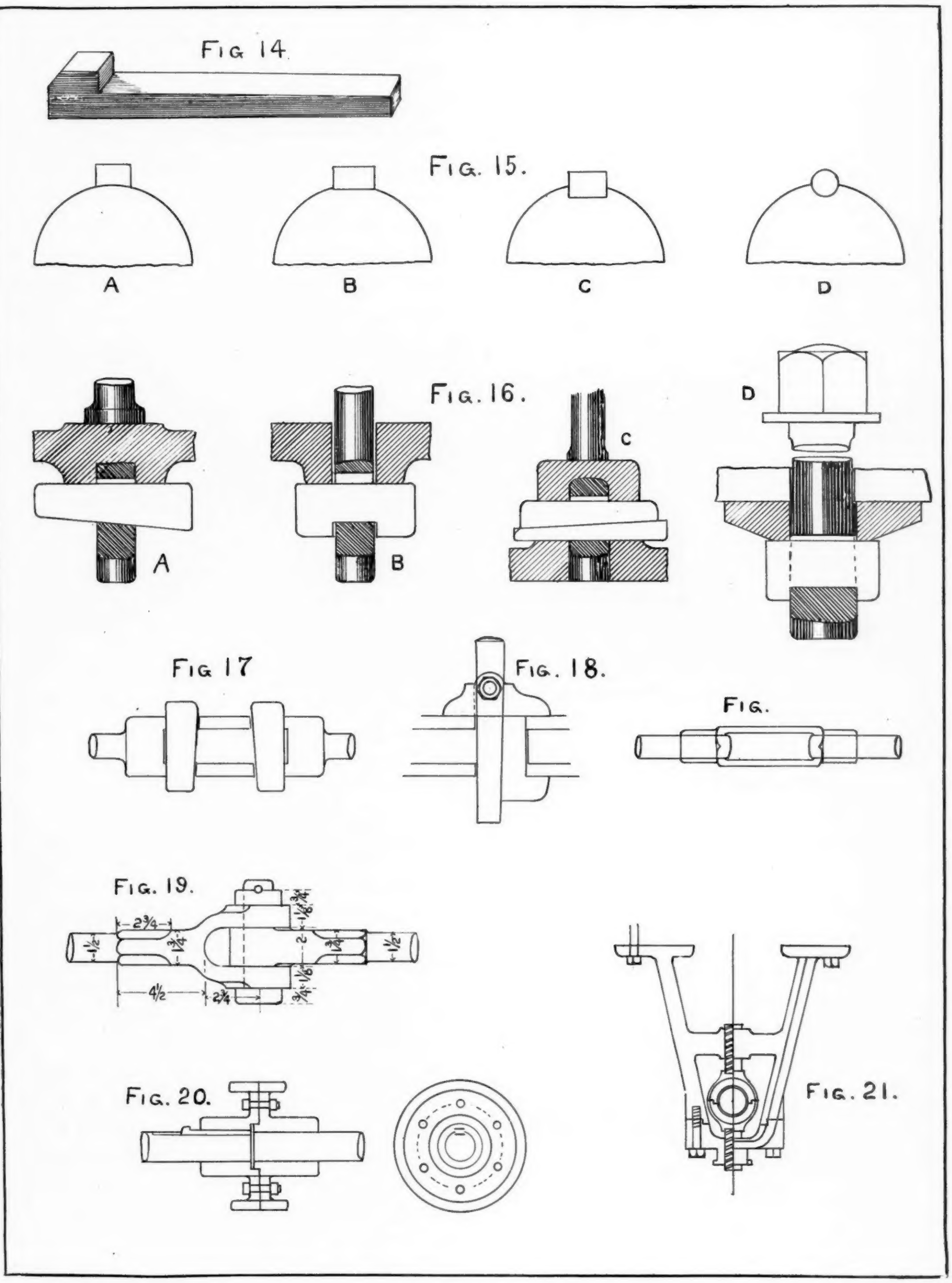


Fig 14.
Fig. 15.
A
B
C
D
Fig. 16.
A
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C
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Fig 17
Fig. 18.
Fig.
Fig. 19.
Fig. 20.
Fig. 21.

AMATEUR WORK

77 KILBY ST., BOSTON

DRAPER PUBLISHING CO., PUBLISHERS.

A Monthly Magazine of the Useful Arts and Sciences. Pubshed on the first of each month for the benefit and instructio, of the amateur worker.

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TO ADVERTISERS.

New advertisements, or changes, intended for a particular issue, should reach the office on or before the 15th of the previous month.

Entered at the Post-office, Boston, as second-class mail matter Jan. 14, 1902.

FEBRUARY, 1904.

The turning lathe premium announced in the previous issue is quite as successful as we anticipated it would be, and many readers of this magazine will soon be the happy owners of these lathes. Those who have visited our office, and seen the one here on exhibition, have expressed the opinion that they do not see how we can offer such a fine lathe for such a small number of subscriptions. It certainly is a very liberal offer, and we are confident that every reader without a lathe would earnestly wish for one could they but see it. We will make this an easy matter in the following way; for the first one hundred lathes, we will receive subscriptions for one-half the specified number, the balance payable in cash at the rate of fifty cents for each subscription lacking the requisite number. Six subscriptions and three dollars would, under this arrangement, enable a subscriber to obtain the smaller lathe; and seven subsciptions and four dollars, the larger one. The little work required to get this number of subscriptions should make the lathe easily obtained by anyone. Try it.

As many of our readers are interested in electricity, we have arranged for a series of articles on "Electricity by Experiment," the first chapter to be published in the next issue. Not only will many interesting experiments be given, but complete descriptions of how to make the apparatus necessary to perform them. At the same time, care has been taken to keep the character of the experiments and the necessary apparatus, to as simple lines as the subject will admit. Anyone desiring to thoroughly study this important subject should become a regular reader of this magazine. Those soliciting subscriptions should call attention to this series of articles when talking with those likely to be interested in them.

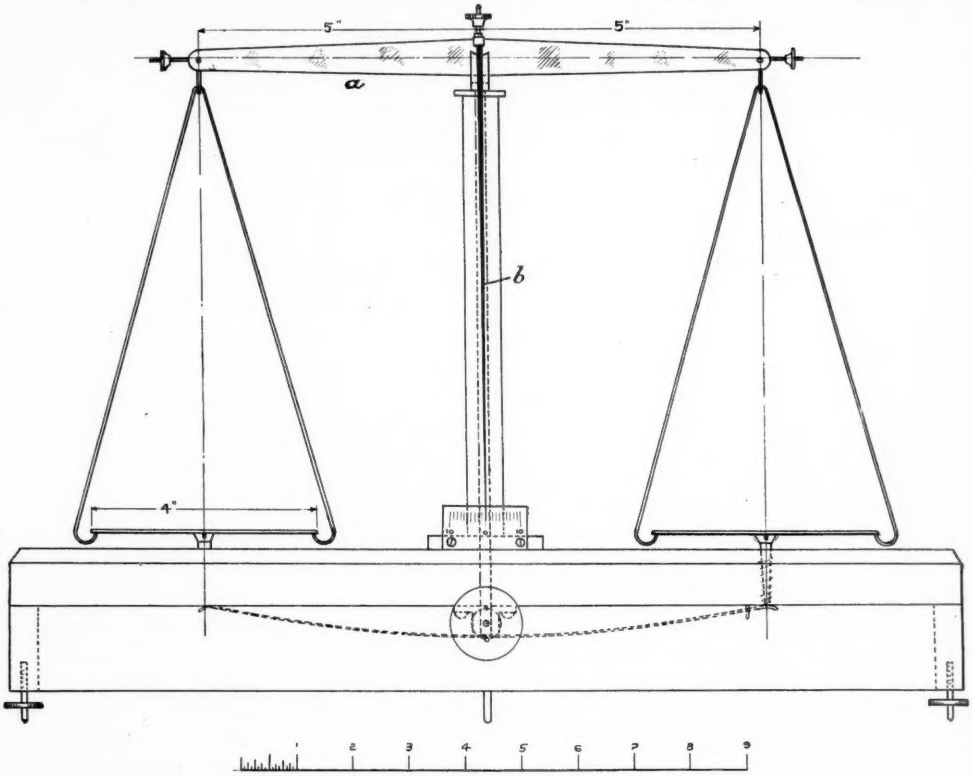
A new gem, lilac-colored and transparent, has been found in two distinct places in California, the most plentiful deposit being only a short distance from the town of Palo, and within a mile of a well known rubellite mine. Dr. Baskerville gives it the name of Kunzite, in honor of its discoverer, Dr. Kunz, who has described its tint as as sort of "rosy lilac," varying from a very pale tinge when looked at traversely, to a rich amethystine hue when observed lengthwise. When cut and mounted in a certain way, one of these crystals yields a gem of unusual beauty. The discovery is of more than ordinary interest because nothing similar to the new gem has ever been seen by gem experts or jeweller's before. In the course of the tests by Dr. Baskerville, the Kunsite crystals were subjected to the action of ultraviolet light without showing any evidence of flourescence or phosphorescence, and it was not until it was subjected to the bombardment of X-rays of very high penetration that it became at all fluorescent. On its removal to a dark chamber, it exhibited a persistent white luminosity never before observed in its class of minerals.

A remarkable pearl cluster from Shark's Bay, West Australia, will be exhibited at the St. Louis Exhibition by C. A. Burt. It consists of about 150 pearls in a solid cluster, and measures several inches, and is about ½ inches thick. A cluster known as the Southern Cross, found some years ago at the Laceped Islands, was sold for close upon $50,000, and judging from this, the cluster should be worth from $75,000 to $100,000.

A SIMPLE BALANCE.

ROBERT GIBSON GRISWOLD.

A pair of good balances is a very valuable acquisition to the amateur's dark room or laboratory, and they are often quite expensive. The one herein described is not very hard to build, is very sensitive, and compares very favorably with those being sold in the market for $15 to $20. In fact, about the only thing in a balance that does cost money is the skill necessary to adjust them, and with ordinary patience, this can readily be done by an amateur so that the balance will render excellent service.



The beam a is cut from $\frac{1}{8}''$ sheet brass. Select a piece of sheet brass of the stated thickness, which is very flat and straight. Then lay out the shape of the beam thereon, and with the aid of a hack-saw and file, carefully cut out the beam and finish it as smoothly as possible with a dead smooth file, then crocus cloth and oil. Lay out a centre line passing through the centres of the end edges, and another at right-angles thereto at the centre. Then lay off the three holes for the knife edges so that the upper edge of the holes at the ends just touch the line and the bottom edge of the centre hole does the same. The holes at the ends are $\frac{1}{16}''$ and the central hole $\frac{1}{8}''$ in diameter. Take great care to drill them parallel.

At each end file a $\frac{1}{16}''$ slot forming a fork as shown in Fig. 2. This is to accommodate the pan hangers. The small adjusting screws at the ends are pieces of $\frac{1}{16}''$ brass wire threaded with a

small die of about 60 threads per inch. One end is flattened and soldered to the back of the beam with a small bit of solder. The nuts are cut from a $\frac{1}{4}''$ brass rod and may be given a knurled edge by pressing on the edge with a mill file while rolling the nut on a hard block, provided no lathe and knurl are at hand. The end knife edges are made of $\frac{1}{16}''$ steel and the middle one of $\frac{1}{8}''$ round steel. Fig. 3 shows the general form of the edges and the end edges may be made by grinding a hollow on opposite sides so that the upper edge is about a 60° angle. The middle edge is filed down so that the edges on both ends are exactly in line. These knives are annealed before filing to rough shape, then hardened and ground on an oil stone to a keen edge. They must be placed in the beam so that all three edges are exactly in line; if not, slightly bend the beam by pening at the middle until they are so.

From a stout sewing needle make two hooks, as in Fig. 4, the hooks forming a right angle with each other. Anneal the needle first, and bend while still red, then harden by plunging into water. Polish the bearing surfaces with a stick and crushed rotten stone. The semi-circular groove in the end edges will prevent the hook from turning and striking the sides of the beam fork. The pointer or spear *b* may be made of $\frac{1}{16}''$ spring brass wire, or cut from a flat sheet and filed to shape, which really makes the best job. Fig. 5 shows the method of making the top, and the gravity bob screw serves a double purpose in holding it in place. A small groove should be filed in the beam to keep it always in the correct position. The spear must extend far enough beyond the knife edge to allow the supporting fork to clear.


Fig. 2.

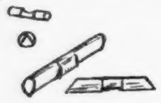


Fig. 3.


Fig. 4.

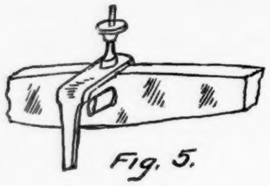


Fig. 5.


Fig. 6.


Fig. 7.

The pans are made of $\frac{1}{16}''$ sheet aluminum, and with bows or hanging wires of either aluminum or German silver, riveted firmly to the pans from underneath as shown. The pans are 4″ in diameter. In Fig. 6 is shown the supporting fork for the middle knife edge, and it should be filed out of a piece of tool steel that has been well annealed. Polish the bottom of the V well, that there may be little friction at this point. On the outside, as shown in faint lines, cement small pieces of glass to keep the edge from sliding too and fro. The knife must be just a little shorter than the distance between the end plates of glass, and should also be ground to a keen point, as shown in Fig. 3, to reduce the possible friction to a minimum. Mount this fork on a $\frac{3}{16}''$ brass rod long enough to pass through the base as shown.

The column is made of $\frac{5}{8}''$ tubing, and a flat piece soldered to each end, one to form a base and the other the top. Each is drilled to accommodate the rod which must be a very snug fit, but still free. To the base secure a piece of white celluloid, and mark twenty equal dimensions as shown. The base needs no description other than that it must be made of some hard wood, either walnut, mahogany or cherry. It is provided with two leveling screws and a stationary pin in the rear. Two ordinary brass wood screws are inserted directly under the middle of the pans to keep them from swinging. The heads should have thin pieces of felt glued to them, and by screwing them in or out, the spear may be made to point exactly to zero when at rest.

Under the base is the lifting mechanism, which is shown in greater detail in Fig. 7. The $\frac{1}{8}''$ rod passing in from the front terminates in a hook, and the latter is provided with a pin set at a $\frac{1}{4}''$ radius, which, by the rotation of the shaft, causes

the rod carrying the beam support to rise and fall. To the bottom of this vertical rod is soldered a long, thin, brass spring which bears against the under side of the base, and keeps the beam from swinging from side to side, and to further secure it, a couple of brass nails may be driven into the base at one end. The outer end of the lifting shaft is provided with a knurled head 1 ½″ diameter, by means of which the beam is raised. File a very shallow groove in the brass spring directly under the vertical rod, into which the pin may slip and remain, to prevent turning while in use.

Now adjust the balance by means of the end screws until the spear stands at zero. Place any weight on the left pan and balance it exactly by placing small weights and finally sand on the right pan. Then transpose the weights, and if the pointer still swings to zero at rest the beam is correct. If not, the heavier weight will have been on the short arm, and this must be lengthened. To do this, lay the beam on a smooth piece of iron and lightly tap it with a flat face hammer. This will stretch it lightly. Now return it to the rest and balance again, repeating the above operation until an exact balance is secured upon a transposition of weights.

The sensibility of the balance is effected by the small gravity bob on top; raising it increases the sensibility and lowering it decreases the sensibility. With careful work, and adjustment of the gravity bob, this balance should indicate a tenth of a grain with perfect distinctness under a load of say ten ounces. Polish all the metal forks and give a good coat of lacquer before making final adjustment.

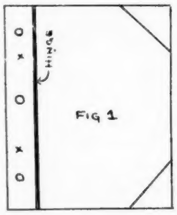
A MECHANIC'S NOTE-BOOK.

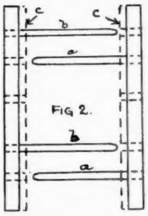
"AMATEUR."

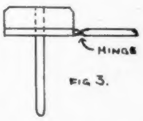
In almost anyone's daily reading and experience he comes across many notes and sketches which are worth saving for future reference. These are apt to be taken down on loose sheets of paper, and lost before being needed again. A description of a simple note book and some methods of arranging material so that it will be easily found when wanted, is here given.

Of course, any kind of note book can be used and information, tables, etc., put in as fast as found, but in this way it will be difficult to find any desired article without going through the whole mass. It is therefore desirable to have some kind of loose-leaf, or expansive book, which will allow of any desired arrangement. There are several kinds on the market, but the good ones are rather expensive, and those with a flat binder put through and bent over, are objectionable from the fact that when the book is separated it is necessary to remove the binders, leaving the sheets loose, which is not only troublesome, but after a time the holes in the sheet become so worn that they are useless. The following is the description of a note book made by the writer, which allows easy separation for insertion rearrangement, and is nearly as easy to write in as a bound book.

At almost any stationary stores "Students' note book covers" can be obtained; these are board covers like Fig. 2, with a hinge and a narrow strip along one edge with eyelets to take binders, which are bent over with the paper between. They come in several sizes, and a pair should be obtained of the size desired for the note book, say, 6″ x 8″ or 8″ x 10″, the latter being a handy size as it is large enough to accommodate quite a large table or sketch. If these are not obtainable, the cover can be made of an old book cover or a piece of pasteboard covered with cambric pasted on. The narrow part is about ¾″ wide and there is about ⅛″ left between the two for the hinge, the covering being pressed down between them to keep them apart. The inside is then lined with paper.







If the cover is purchased, there will be a hole near each end, and perhaps in the middle of the narrow part, two more holes about ⅛″ diameter should be punched about ¾″ from those already there, as shown by the crosses. Two pieces of hard wood about ¼″ thick, and the same length and width as the end pieces are procured, and also four pieces of brass rod, ⅛″ diameter and about ½″ longer than the desired thickness of the book. These should have the ends

smoothly rounded, and are to be fastened into the wood strips as shown in Fig. 2. A good way to do this is to thread the end and screw it into the wood, or it may be carefully driven in and held by friction, or a brass screw.

The hole opposite each pin should be a loose fit to allow the pin to pass in when there are few leaves in the book. The covers are slipped on as shown by the dotted lines *c*, *c*, and the cover is ready for use. The middle hole is to pass a cord through to hold the book together. The best paper for this use is a thin bond, as it bends easier and is thin enough to lay on a drawing and trace through, if desired. It can be obtained at a stationers for from 50 cents to $1. 50 per ream of 500 sheets and can easily be trimmed to suit, but the best way will be to buy a ream and make the book to suit. The sheets are all to be punched with the five holes, and care must be taken to have all punched as near alike as possible, so that the edge of the book will be fairly even. They can be then slipped on to the pins and the book is complete. It will be seen now, that if it is desired to separate the book at any point to insert or remove a leaf, a part will stay on the pins *b b*, and the rest on pins *a a*, and it is readily put together again, and held by a cord passed through the middle hole.

The best way of keeping the material that the writer has been able to find is to divide the book into several different divisions or heads, such as, workshop receipts, useful formulas, references to articles, etc., personal needs governing the number and kind of classification. Each article as it is put into the book is filed alphabetically in its proper head. As the size of each division increases it will be found helpful to have the leaves tabbed with the letters of the alphabet. These may be made of card about ¼″ wide and pasted on the leaf with the letter extending out from the body of the book, thus allowing easy access to any letter. If desired, these alphabets may be purchased of leather all gummed, ready to stick in place, and are much more durable than plain paper ones.

Short formulas, etc., can be copied in directly and preserved intact, clippings may be pasted in, but should be pasted along the inner edge only, to allow the book to open smoothly. Any article which is too long to be copied and cannot be cut out may have its location noted; the publication, date and page; so that it will be easily found. Sketches or diagrams can be drawn out and inked if desired; this is a very good idea, as blue prints can be taken through the thin paper if a copy is desired. As fast as notes are taken the book is taken apart and the page inserted in its proper alphabetical position under its right head.

In the writer's experience of compiling data, references, etc. this method is the one which has been of the greatest use to him, and it is hoped that it will also prove useful to at least some of the readers of AMATEUR WORK.

ELEMENTARY MECHANICS.

PROF. J. A. COOLIDGE, ENGLISH HIGH SCHOOL, CAMBRIDGE, MASS.

I. The Lever.

How can a teamster with a long stick of timber lift one corner of his heavily loaded wagon, so that a wheel can be taken off? How can a freight agent with an iron bar move a freight car weighing 20 tons by simply putting his bar behind one of the wheels and using a very moderate amount of force? How can a carpenter with a hammer pull a nail from a board? These and many other similar questions in mechanics, arising in our daily life, are before us demanding an answer, and we will now set about our task, making our own simple and inexpensive apparatus, that shall, however, give us accurate results. The first principle to receive our consideration is:—

THE LEVER.

For our levers, we need two pieces of wood (maple, or some other hard wood is better) 40″ long, 2″ wide, and 1″ thick. These must be carefully and evenly planed and sandpapered, so that they will balance on a pivot placed under the centre of the board. They should be marked off accuractely in inches and half inches, and then given a coat of shellac. We will now make two pivot blocks on which our levers shall turn. They should be triangular in section, 4″ long and 2″ wide. A block, or box filled with sand, 4″ square, and two pieces of wood 2″ x 3″ x 5″ will complete our wood work.

We suppose everybody has access to a carpenter's bench and tools, for if one does not have them himself, he will find almost any carpenter, if approached wisely, sufficiently interested in his project to be willing to allow the use of his bench and tools and also to give valuable advice. We shall need a set of weights to use in these experiments and the others that will follow. To make these, two ways are suggested. Take an ordinary screw eye or screw hook, twist about it a short piece of wire, insert this in a quarter pound baking powder box (or a smaller one if you can get one) and pour in some melted lead. See Fig. 1. By filling our can to different depths we can get a number of weights of different sizes. These

we will take to some store where we can cut or file off enough until they are of exactly the required weight. Any grocer will give the use of his scales for this purpose. We will make a se* consisting of one 4 oz. one 8 oz. two 16 oz. two 32 oz. one 48 oz. and one 64 oz., and a convenient box ready for use and storage. The screw hooks can be bought for five cents a dozen. The lead will melt in any iron pan on a kitchen stove. Moulds can also be made by placing two pieces of smoothly planed hard wood of fine grain, boring holes of different sizes centreing on the joint, and held together by a large screw or clamp at each end.

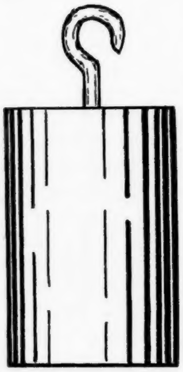


FIG. 1.

After boring the holes, smooth the surface with graphite powder. The screw eyes are held in position while poring, by putting the screw through thin pieces of wood, and placed across the centre of the hole.

A cheaper set of weights may be made by sewing up some little bags of cloth and filling them with sand so coarse that it will not sift through. Our apparatus may be seen when adjusted, Fig. 2. Let us call the weight at the right, the power, *F*, the fulcrum or pivot, *W*, the weight to be lifted, *B*, the box that raises the lever above the table on which it rests so that the weights *P* and *W* may be suspended from the bar by loops of wire or twine, *R* and *R* two blocks placed under the ends of the lever to prevent it from turning too far. The distance along the bar from *F* to *P* is the power arm and from *F* to *W* is the weight arm

EXPERIMENT I.

Support the bar at its centre on *F*.

a. Hang a 16 oz. weight 10″ to the left of *F*. See if a 16 oz. power 10″ to right of *F* will balance.

b. Hang a 32 oz. weight 5″ to the left of *F*. See if a 16 oz. power 10″ to right of *F* will balance.

c. Hang a 64 oz. weight 6″ to the left of *F*. See if a 32 oz. power 10″ to right of *F* will balance.

d. Hang a 20 oz. weight 4″ to the left of *F*. See if a 4 oz. power 20″ to right of *F* will balance.

Try two more cases using other weights and distances. Notice that in cases *b c*, *d*, a small power at a long distance will balance a large weight at a short distance. Also that the power $P \times$ the power arm $P F$ equals the wt. $W \times$ the wt. arm $W F$. This is the law of the lever, discovered by Archimedes, 250 B. C. We have now an explanation of the teamster lifting his wagon. A man weighing 160 lbs, using his weight as a force on the end of a timber 12 ft. long, if the fulcrum is 10 ft. from the end, exerts a turning force of 10 × 160, or 1600. If the wagon rests on the end of the lever 2 ft. from the fulcrum, the weight of the wagon × 2 equals 1600. Therefore the wagon must weigh 800 lbs. With a longer bar and a shorter weight arm, he can lift more.

In all the trials just made, we have rested the bar at its centre. Now we will place the pivot nearer one end and see if the weight of the bar has any effect. Before doing this, let us weigh carefully one of our levers at some store and on the bar mark its weight in ounces.

EXPERIMENT II.

Let us hang a 32 oz. weight, 5″ from the left end of lever, with the fulcrum 5″ further to the right. Our bar will balance, perhaps, without any power, i. e., there is so much more of the bar on the right of the fulcrum that a weight of 32 oz. is needed on the left, to have the lever balance. See Fig. III.

According to the law of the lever, $P \times P A$ equals $W \times W A$; but the only power used is the weight of the lever, therefore, $P \times P A$ equals 32 × 5. As P is the

FIG. 2.

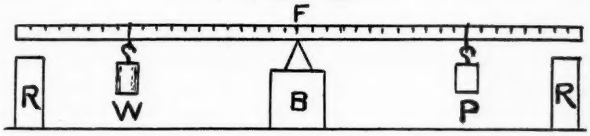


FIG. 3.

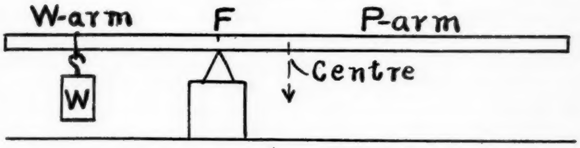
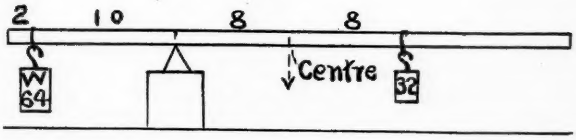


FIG. 4



weight of the lever, its distance should be 10 inches if the lever weighs 1 pound, or less if the lever weighs more than a pound. If the distance is 10 inches we find the place where it acts is at the centre of the lever. If this is so the weight of a lever plays a part in its use, although, unless it is very heavy, a comparatively small part. To test the accuracy of this experiment, let us take the lever that we have not weighed, and arrange it as in Fig. III. When we have made it, lower arm, weight arm, and weight. balance, we

have (P arm Wt A arm, and Wt). As $P \times P\ A$ equals $W \times W\ A$, we can find P by solving this equation, or dividing $W \times W\ A$ by $P\ A$. But as P is the weight of the lever, we have found its weight. Now we will weigh this lever, and we should find our results correct within one or two ounces.

EXPERIMENT III.

To test the accuracy of our conclusions place our pivot 12 inches from the left end of the lever. See Fig. IV. Hang a 64 oz. weight 10 inches from the pivot and see what force, 16 inches to the right, will balance this weight. Our power now consists of two parts, one the weight of the bar which acts at the centre, and the other, the smaller weight hung 16 inches to the right of the pivot. Our calculation will be;

$Wt \times W\ A$ arm = wt. of lever × distance of F to centre + $P \times P$ arm.

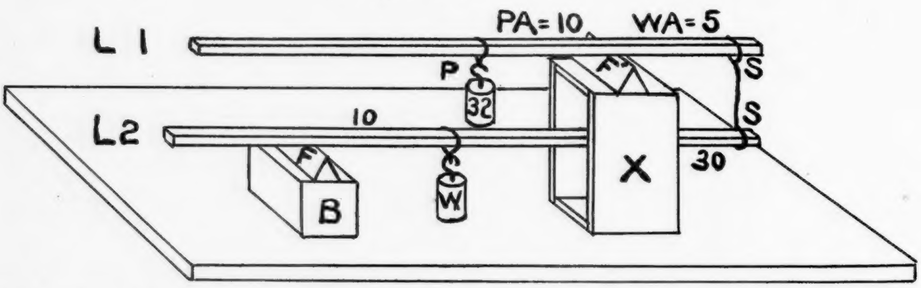
If our bar weighs 16 oz. these should be

$64 \times 10 = (16 \times 8) + 32 \times 16 = 640 = 128 + 512$

$360 \div 5 = 72$. In lever 1 the weight is the pull exerted on the string S and is not really a weight lifted, but become sthe force in lever 2. This force, then, in lever 2 is 72 oz. As S is 30 in. from F in lever 2, $P \times P\ A = 72 \times 30 = 2160$. W in lever 2 is equal to the weight of the bar together with the weight W, which we will hang at the centre of the bar 2. $W \times W\ A$ must equal 2160, and as $W\ A = 10$, $W, = 2160 \div 10$ or 216 oz. If one bar 2 weighs 16 oz. the weight W should be 200 oz. and we must use about all the weights we have made. The questions of the bar moving a freight car, and the hammer drawing a nail cease to be incredible when we see this small force overcoming so large a resistance.

We ought to try two or three more cases of this kind, but with the directions already given, the task is an easy one. Usually in class 1, always in class II, the power is small and the weight large. There remains a kind of lever, class III, in which the power is

FIG. 5.



In the experiments just performed, the power is always at, or near one end, the weight is at the other end and the fulcrum or pivot between. The power acts vertically downward. Levers of this kind are called levers of class I. We must now consider class II. where the fulcrum is at the end of the lever, and the power is exerted upward. For experiments of this kind, a spring balance, measuring from 1 to 64 oz. is very desirable, as the balance can measure a force exerted vertically upward. We will, however, arrange two levers so that on one of them the force will be exerted upward with an amount that can be measured.

EXPERIMENT IV.

The lever 1 rests on a box X, whose top and bottom have been removed so that lever 2 can pass through the opening and rest with one end on B. Our only need of lever 1 is to change a downward force at P into an upward force at S. In this way the pull on the string S raises the right end of lever 2 and with it the weight W. To simplify matters let P be hung at the middle of bar 1, and W at the middle of bar 2. We find then in lever 1, that the total force is P + the weight of bar 1, which we will make equal to 36 oz.

As this is to be 10 inches from the pivot, $P \times P\ A = 36 \times 10 = 360$. Then in lever 1 $W \times W\ A = 360$, but we have made $W\ A = 5$ inches; therefore, $W =$

always larger than the weight. The arrangement of a lever of this class is much like that in class II; the pivot is at the end but must hold that end down as the tendency of that end is to fly up. the power is near the pivot and the weight at the other end.

EXPERIMENT V.

Arrange lever 2 as in Fig. 5, only tie the bar down at F by means of a string run through a hole bored in block B. Some weights must be placed on B to keep it down. S and W in Fig. 5 must change places. The calculations will be the same as in case II, only the power arm is short and the weight arm long. Make S 64 oz. and the distance from F 10 inches; if W is 32 inches from F its value must be 20 oz. Make one or two additional trials using your own values. A fishing pole is, perhaps the simplest implement that is a lever of class III.

We must not think that, because we can make a small force lift a large weight, we are gaining at every point. There is no gain without a corresponding loss and what we gain in raising a large weight, we lose in being able to move it only a small distance, or if we move a small weight with a large force, we gain in making a small weight move very fast or of through a long distance. These are the advantages of most machines, and make them well worth studying.

HOW TO BUILD A SAILBOAT.

CARL H. CLARK.

II. Setting Up The Frame.

Fig. 6 shows the method of setting up the foundation for building. It is supported as shown and braced fore and aft and sidewise very strongly, as there may be considerable strain brought to bear upon it. The wedge shaped pieces at the ends are cut out and put on to give further support to the keel. The curve should be carefully cut to fit the mould as nearly as possible at every point. The mould positions should be marked on the foundation for use in bending the keel. It would be possible to build up a foundation of blocks, beveling them off to fit the keel mould and bracing them securely. This method is not as good as the former, but with careful work, and sufficient skill, a good job may be done. In either case, it should be formed that the load water line marked on the mould will be level. This will make it easier to set up the frame.

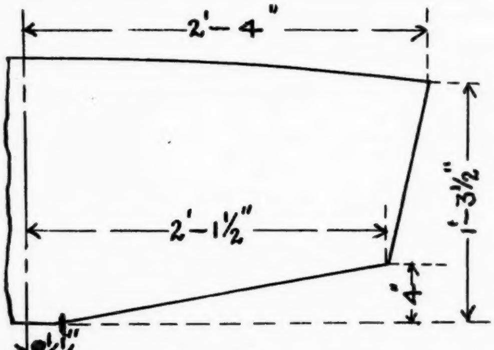


FIG 5.

The keel is formed of a 2" oak plank about 20' long, and 10" wide. The half breadths at each mould point are given in line 6 of the laying off table, except that 1 ½" must be added to each one to allow for the back rabbet mentioned above, and shown in Fig. 4. This will make the greatest width 10" on numbers 3, 4 and 5, the others being 4 ½", 5 ⅝" and 5 ½" respectively. The width at the stern board is 5" and where the stem joins the keel it is 4". It should be noted that the positions of the moulds as marked on the keel will not be evenly spaced, as the distance between them is not measured horizontally, but around the keel mould, as the keel is to be finally bent. This spacing can be obtained by measuring from one to the other around the keel mould. The batten is again used to draw the curved lines as before. The keel is trimmed to shape and then turned over and the outline of the under side drawn in the same manner with the table dimensions.

The rabbet is now to be cut 1 ¼" deep, along the line on the bottom, this allows the keel to project ½" below the ¾" plank. The rabbet may be left square for the present. The stem is a natural crook knee about 2" thick, worked out to the shape of the stem mould and scarfed to the keel. This scarf should be marked on the keel mould and transferred both to the keel and the stem, allowing the scarf to be fitted approximately before setting up. Following the rabbet line there is a rabbet cut in the stem to take the ends of the plank. It is ¾" deep and can be cut only approximately until the stem is in place and the angle of the plank definitely determined.

The sternboard is of 1 ¼" oak cut to the shape shown in Fig. 5. The rounded upper edge should be left full and trimmed off after the deck beams are in place. The edges also are beveled after it is set up. The two centre board logs are to be gotten out of 2" plank 11" long and 8" deep in the widest part. They should conform to the shape of the mould, so as to fit nicely on the top of the keel after it is bent. The edges must be perfectly square and even, as the joint between them and the keel must be water tight. The top edge must be straight and square as the sheathing of the centreboard box fits against it.

The keel is now to be bent into the form. To do this it will be necessary to thoroughly steam it, preferably by putting into a steam box, but if this is not at hand it can be steamed by wrapping it with cloths and keeping the latter saturated with boiling water for some time until the keel is limber enough to bend to shape easily. The ends, where there is no curve do not, of course need steaming. When it is limber enough to almost bend of its own weight it can be laid into the form and braced into place, being sure that the mould lines on it coincide with those on the foundation. Braces are placed as closely as possible, bearing against the beams overhead. These braces can be cut rather long, and by fixing the top and sliding the lower end along the keel, a wedge action may be obtained. All the braces should be forced down together to avoid straining in any particular place. It will be well to place a piece of board under the lower end of each brace to avoid any tendency to concentrate the pressure and split the keel.

The centreboard slot would best not be cut until after the keel has been bent, unless the builder is a

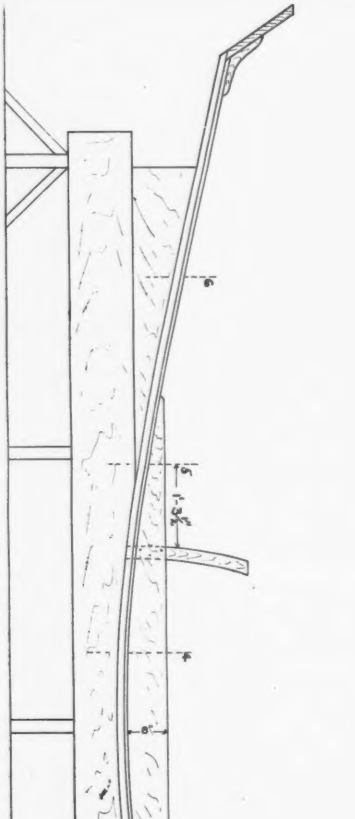


Fig. 6.

very skillful workman, as the removal of the material of the slot will cause a tendency to a sudden bend at the ends of the slot, which may be rather difficult to get out. The keel should be allowed to rest for a day or two until thoroughly dry, before being disturbed. Indeed the braces should never be entirely removed, and if, for any purpose one is taken away it should be replaced as soon as possible. It is a long time before a bent timber entirely loses its tendency to spring back. After the keel is in place the mould should be laid upon it to make sure that it is to the exact shape.

The centreboard slot should be next cut. The dimensions for the length are as shown in Fig. 6 and it is 1 ⅝″ wide. It should be perfectly sraight and square all through. Holes should be bored along the centre line with a 1 ½″ auger and the remainder trimmed out. Braces may be removed one at a time while it is being cut. The centreboard logs are next carefully fitted to the top of the keel, one on each side of the slot. This joint, as before stated, is one of the most important in the boat and ought to be very carefully made. The uprights at each end of the box are 1 ⅝″ thick, 3″ wide and about 27″ long.

The forward one stands plumb, and the after one is curved on about a 5 ft. radius from the pin on which the centreboard is hung. As will be seen, these pieces extend down through the keel. They should be put into place and the logs clamped to them and the whole clamped to the keel and carefully fitted into place before any fastening is done. The centerboard logs are to be held in place by long rivets extending down through the keel. These rivets are galvanized iron ½″ diameter, driven from the bottom. The washer on the top of the rivet is set down below the surface by boring down about ¾″ with a bit slightly larger than the washer. This is necessary, to not interfere with the next board of the box side. Before boring the holes for the rivets, the pieces should be taken down and all surfaces given a coat of thick lead. A thread of cotton, saturated in lead is now placed between the logs and each vertical piece, and a long thread is also laid along between the logs and the keel, quite close to the inside edge of the log, so as to be inside of the line of the fastenings. The whole may then be clamped up again into place, being sure that the centreboard uprights are back to the entreme ends of the slot and that everything is in its former place. Holes may now be bored for the rivets, and each rivet should be driven as fast as bored for, to avoid any chance of any parts slipping. To get these logs into place the braces will need to be removed, but they may be replaced, resting on the logs themselves, and thus aid in keeping them in position.

When the logs have been fastened into place the vertical pieces may each have three short rivets about ¼″ diameter driven through them and the logs. It will be seen that this makes a very strong back-bone for the boat and tends to keep her in shape. The stem is now to be fitted on the scarf at the forward end of the keel. It is so fitted that when in place it

and the keel will follow the mould. The scarf, or diagonal joint, should be about 15″ long, and as good a fit as is possible to get. The keel should be tapered down to about $\frac{3}{4}''$ thick at the forward edge. They are fastened together with $\frac{1}{2}''$ rivets, about four being used. The after two can be left until later if the foundation interferes with driving them now. The stem must be exactly in line with the two centerboard uprights, and also plumb. The after end of the stem is jogged down to allow the maststep to fit over it. The rivet through this part must, in any case, be left until the step is in place.

The sternboard, Fig. 5 is $1\frac{1}{4}''$ thick, and is cut to those dimensions. The stern knee is 2″ thick, each arm being 9″ long. It should be natural growth if possible. The angle is obtained from the keel mould or from the original draft on the floor. Where the sternboard fits on to the keel, it is cut down $\frac{3}{4}''$ thus allowing the edge of the sternboard to lie even with the underside of the projecting back rabbet and allows the plank to fit on both the rabbet surface and the sternboard, as shown in Fig. 6. The under edge of the sternboard is beveled to fit the jog thus made in the keel. The centerline should be left on the sternboard to use in setting up. The sternboard and the knee should be clamped in place and adjusted until the centreline on the sternboard is in line with the stem and centreboard uprights already set up. The sternboard must also be square with the fore and aft line of the keel. These adjustments will be made easy by stretching a line from the centre of the sternboard to the centre of the stem. A sliding line carrying a plumb bob will then tell whether the parts are in their correct positions.

When the sternboard is adjusted, it and the knee may be fastened in place with galvanized screws. It will be found that a little soap or lead on the threads of the screw will make it drive much more easily. The whole should now be painted to prevent checking during the time the boat is being built.

PRINTING FOR BEGINNERS.

FREDERICK A. DRAPER.

IV. Composition.

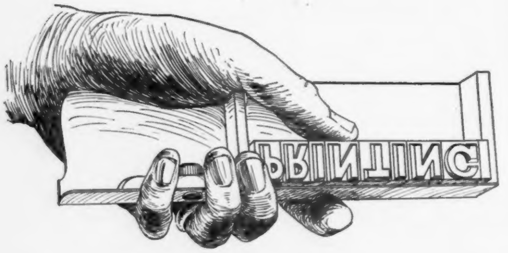
We have now reached that part of the work in which use will be made of all the materials and furnishings previously described. Other necessary adjuncts will be considered when treating of the special work occasioning their use. With a case of type inclined at a suitable angle on a stand before the compositor, the composing stick, fitted with composing rule, held in the left hand as shown in the illustration, the type is gathered with the right hand from their several boxes and placed in the composing stick. This may seem merely a matter of learning the location of the boxes, but experience will show that much enters into it, not noticeable by the casual observer. The beginner should make every effort to follow the methods which long experience have shown to be necessary when quickness and accuracy are to be acquired without undue fatigue to the limbs and body.

One important matter is that of the attitude assumed, a correct one requiring the front of the case, (lower case if a pair) to be level with the elbow, and a platform should be used by short people to secure the correct height. While not keeping the body rigid, excessive motion is to be avoided as tending to tire the worker. The eye should preceed the movements of the hands about the case, the types to be taken being observed with special reference to having the hand secure each one with a single attempt, and not have to make several trials before succeeding. It will be found easiest to do this if the forefinger and thumb are held nearly vertical, and the type taken up by the top ends, the eye having previously located the type to be taken. While carrying to the stick, the fingers turn the type, when necessary, so that the correct end shall be uppermost, and the "nick" on the upper or open side of the stick.

The beginning of a line is at the end of the stick nearest the wrist or adjustable end, and if part of a paragraph, the first line is indented an em quad. In book-work an indention of one and one-half or two em quads is sometimes given, according to the length of the line, and whether widely leaded or not. Immediately after securing one type, the eye is directed to the box for the next one, as, to become a rapid compositor, every movement of eye and hand must be that which will do the most work with the least exertion, and in the shortest time. When the foot of the type has been placed in contact with the one previously placed, release the hold of the fingers, allowing the type to drop into place with a slight "click." In the smaller sizes of type, the end of the left thumb is lightly pressed against the type, and gently lowers it into the stick. Before each word put a "thick" or 3 em space. With very "extended" advertising type, an en quad is often used for spacing. When a line is about completed, observe the words which follow, and select the word or syllable with which to

begin the next line. It will frequently happen that the last word or syllable does not exactly fill the line, being a trifle short or over the needed length.

In such a case the thick spaces are replaced with en quads or middling spaces as the case may be. Such changes in the spacing are made, where possible, between words which do not end in the same vertical line with those in the line above; i. e., the aim in spacing should be much the same as with shingling a roof, to "break joints." This idea can be followed only to a limited extent, however, and is qualified by another equally important one of avoiding the division of words and use of the hyphen, wherever possible to space out the line without using too wide or too thin spacing. In setting very narrow measure, words may occur in such order that no division in the end word is possible, and to put this word on the following line would require objectionably wide spacing in those remaining. In such a case "thin" spaces are put between the letters of one or more words to lengthen them and thus reduce the spacing between words to correct space.



The aim in spacing is to have all lines of exactly uniform length, and much care must be used to secure this, otherwise, the type cannot be firmly locked up in the chase. A "pied" form will take far greater time to make right than will be required to secure correct spacing. It frequently happens that in setting a line, the type will incline a little to one side, thus preventing the final spacing. This is avoided as much as possible by the pressure of the left thumb, but may be entirely removed by lifting the end of the line towards which the types lean, putting in the last space necessary to justify the line, and then pressing the type down into the stick.

The following punctuation marks are usually cast on a thin body, and should each have a thin space between it and the preceeding word: — ; : ! ?. For the quotation, commas are turned (") the opposite way from that when used regular; two apostrophes (") being used at the end of the quotation. Parantheses ( ) and brackets [ ] are not separated by spaces from the words they enclose, the same character answering for both ends by turning one. Place a thick space after the comma.

As composition proceeds, it is desirable to glance along the line, before finally spacing out, to see if the correct letters have been obtained. The experienced compositor does this with the faces of the type upside down, and to the beginner this will be rather confusing, but practice will soon make it easy to do this. Corrections are more easily made if the line has not been spaced, and require much less time and trouble than when made in the galley or form. A "clean proof" should be the aim of every compositor; one full of errors indicates either carelessness in setting up, or in the previous distribution, and is quite likely to share in both these faults. The copy is usually read when picking up the spaces, close observation not being necessary to secure them. The varying thicknesses of letters will frequently help to detect a wrong letter which has been dropped into a different box from that to which it belongs.

Some job fonts contain two styles of the same letter, as here illustrated, **s** and *s*, the custom being to use that of eccentric shape only at the ending of a word or line. The words "*of*" and "*The*" are also included in some job fonts, their use being regulated by the make up of the surrounding type. Upon the completion of one line, the next is begun after placing a lead, if single leaded, or two leads if double leaded, against the line of type.

Light.

When we speak of an instantaneous exposure, we think we have given something very short. And it is very difficult to realize that our conception of time, according to human standards, may be very far away from what actually takes place. Now, light is estimated in round figures to travel at 190,000 miles per second, and if we estimate the length of the beam that is admitted by our shutter when making a snapshot, we shall get some idea of the enormous possibilities of energy expended in producing the image. For instance, we set our shutter for the 1-20th of a second; that means that a stream of light 9.500 miles long has entered our lens and impinged on the plate, and even for 1-1000th of a second exposure means a stream 190 miles long to work with; or, again, if we have occasion to give five minutes exposure, the light that enters the camera last had not left the sun's surface when we began the exposure. *Photographic News.*

Prof. Himstedt, of Freiburg, claims to have made an interesting discovery respecting radium, which seems to show that its existence is far more widespread than heretofore supposed, His experiments are asserted to prove that all products of water and petroleum sources yield a heavy specific gas, closely resembling, and probably identical with the emanation of radium.

THERMIT, THE NEW COMPOUND.

A. FREDERICK COLLINS.

As wonderful in its production of high temperature as liquid air is in its cold producing properties, ranks thermit, the latest invention. This marvellous new compound, to which its inventor, Dr. Hans Goldschmidt, of Essen, Germany, has given the name "Thermit," is made by combining in the proper proportions two elements most frequently occuring on the earth's surface, namely oxygen, in the form of oxides, and aluminum, the metal found in common clay. When these two substances are combined and then ignited, an enormously high temperature, equal to the intense heat of the electric arc light, is instantly produced.

The exact method of making the compound, the simplest way of obtaining the highest caloric value, and the most practicable manner of utilizing the resultant energy created by this process of combustion, have opened a new field of unlimited application, and thus another science is brought into the realm of those termed exact. While the reducing properties of aluminum were discovered at least fifty years ago, the scientific investigators who studied these phonomena overlooked entirely its most essential characteristic. It remained for Dr. Goldschmidt to point and invent a thermit mixture which, when once ignited in a single place, continued its self-combustion throughout its whole mass without any external source of heat. Thus a crusible filled with a seething mass of thermit hot enough for the production of artificial diamonds or the welding of a crank-shank can be held in the hands with impunity, and many other equally interesting and useful experiments may be performed utilizing a temperature diametrically opposite to that of liquid air and in every way as spectacular.

But, unlike liquid air, the commercial value of thermit has already been proven beyond peradventure of a doubt. Its application in the production of pure metals and the faculty with which gigantic pieces of metal are welded together are in evidence in many cities throughout continental Europe.

The thermit compound is a grayish black powder, very like coarse gunpowder in appearance. When it is desired to obtain molten iron either in its pure state, for the arts, or for welding purposes, the aluminum powder and ferro-oxide, or iron rust, are placed in a crucible made of magnesia or other suitable material having high heat resisting qualities. Graphite or clay cruicibles will not answer the purpose, for the heat is so intense that under its influence they commence to bulge until their distortion causes them to crack.

The thermit is ignited by putting in a small pinch of peroxide of barium, and a fuse is led to this and ignited. A reaction takes place almost immediately, and the solid oxygen contained in the iron oxide combines with the aluminum, forming an aluminum oxide, while the iron contained in the oxide of iron runs to the bottom of the crucible, in virtue of being heavier than the aluminum slag separated from it. The reaction producing this remarkable result takes place in less than one minute, without regard to the quantity of thermit used. The result is an enormous heat, developed with safety, while in other and older experiments of external combustion there have been violent and explosive effects, and therefore only the smallest quantities could be tested. The chemical reaction provides a rapid evolution of heat, which when started from a given point, raises the next nearest portion of the mixture to a temperature sufficiently high to cause another reaction, and this mode of heat propagation continues until finally the entire mixture is ignited.

To find a method for the initial ignition of the thermit was in itself no easy task, and while barium peroxide is now used for the purpose of ignition, a long line of experiments were made before it was definitely ascertained that it offered the best medium that could be found. Second only in its usefulness to the production of pure metals, but capable of a more spectacular demonstration, is the thermit welding process. As a method for welding, thermit begins where the blacksmith's forge ends.

It is not intended to use the new process for welding small pieces of iron or steel, but where broken pieces of metal of great size are to be repaired, especially *in situ*, it fulfils a place unsupplied by any other method known. Every up to date road may quickly and cheaply have its rails welded together so that a smooth surface may be obtained. It is therefore readily seen what a useful compound it is.

The Mineral Collector.

A new gasoline motor has appeared with a mechanically operated valve, serving for both admission and exhaust. It is worked by the aid of a sliding sleeve, which surrounds the valve, and a peculiar-shaped cam giving two degrees of lift to the valve. Though the means may be new, the result is not, as a combined inlet and exhaust valve has long been a feature of some horizontal motors.

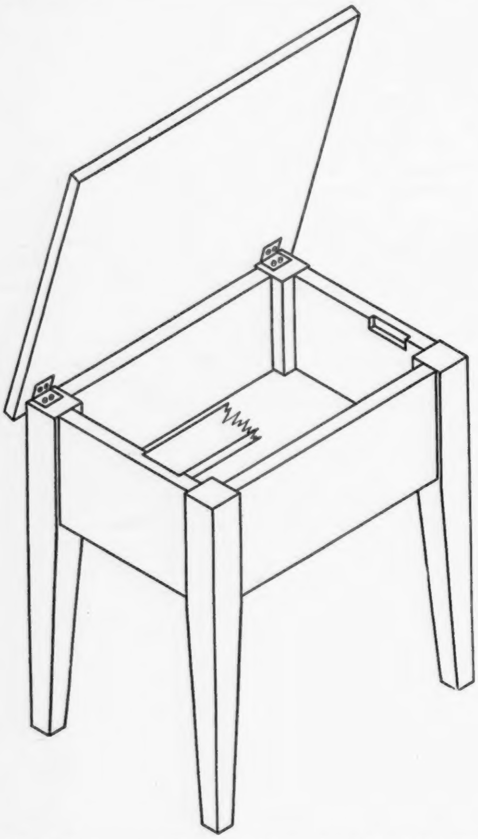
JUNIOR DEPARTMENT

For the Instruction and Information of Younger Readers.

BOOT BLACKING STAND

FRANCIS L. BAIN.

When making any article of furniture it is advisable to first, plane and finish to the proper size, all the smaller and narrower pieces of wood when possible, then finish up the large and wider stock. If this method is adopted the wide stock (such as table tops, box covers, etc.,) has very few opportunities to become warped or checked while lying around waiting to be used after it has once been planed to its proper size.



For this reason the legs of the boot-blacking stand will be considered first of all, then the rails, and lastly the bottom and cover. Any kind of stock may be used for this stand, but pine or whitewood represent the usual choice. The four legs are to be cut from a piece of $1\frac{3}{4}''$ or $2''$ plank, and they should be planed and finished very accurately to the following dimensions, length $15''$, width $1\frac{1}{2}''$, thickness $1\frac{1}{2}''$. After planing, number the first two adjoining sides on each piece (in the order in which they were planed) with small figures 1 and 2 and across these two sides on each piece a line is to be squared $5\frac{1}{4}''$ from one end, and the surfaces are to be tapered with the plane from this line to the opposite end until the latter (which we will now call the bottom of the leg) is $\frac{7}{8}''$ square. When the stand is put together, the two tapered sides face the inner part, while the two straight sides face the outer, or exposed part. A centre line for the dowel holes should now be drawn on the upper end of side No. 1, $\frac{1}{2}''$ from and parallel with the adjoining straight side, and commencing at the top of the leg, the following measurements should be marked off, $\frac{7}{8}''$, $1\frac{1}{2}''$, $1\frac{1}{2}''$. Taking each of these points as a centre, bore a $\frac{3}{8}''$ hole $\frac{3}{4}''$ deep. Repeat this process on the No. 1 and No. 2 sides of each leg, and place them aside until the rails are made.

The rails should be made from $\frac{7}{8}''$ or $1''$ stock, the two long rails finishing $11''$ long, $4\frac{3}{4}''$ wide, $\frac{3}{4}''$ thick, and the two short rails firnishing $7''$ long, $4\frac{3}{4}''$ wide, and $\frac{3}{4}''$ thick. A line should now be drawn on both sides of each piece, which will be just midway between and parallel with the two broad sides of the rail. Commencing at either edge of the rail, mark off the following measurements, and as before bore a $\frac{3}{8}''$hole $\frac{3}{4}''$deep, $\frac{7}{8}''$, $1\frac{1}{2}''$ $1\frac{1}{2}''$. Then cut off 24 pieces of $\frac{3}{8}''$ dowel, each $1\frac{3}{8}''$ long, and having put some liquid glue in the holes in the end of each rail, drive these dowels in as far as they will go; then put some glue into the holes in two of the legs and join them by fitting in place one of the long rails. Repeat this process with the other long rail and the remaining legs, and place each set in a cabinet makers' clamp, screwing it up firmly in order to draw the legs and rail securely togethor. After the glue has hardened or "set" remove from the clamp, and finish setting up the frame by gluing in place this short or end rail. Apply the clamps properly on each side and allow the frame to set for eight or 10 hours.

The bottom, which is to be made next, should finish up $12\frac{1}{4}''$ long, $8\frac{1}{4}''$ wide and $\frac{1}{2}''$ thick, and a little square corner is to be cut out of each corner of the legs. The size of the corner to be cut out is $\frac{5}{8}''$ square. The foot rest for the stand consists of two parts, the cast iron "shoe rest" (to be obtained at any shoe finding supply house and at many hardware stores) and the wooden base or support, which is next to be

made. The finished size of this base is 12 ¾″ long, 2″ wide and ½″ thick, and the cast iron "shoe rest" is to be attached to this piece by means of ⅝″ wood screws. The top is the last piece to be made, and for this purpose a piece of stock must be selected that is free from any warp or check of any kind. This piece is to finish up 15 ½″ long, 11 ½″ wide, and ⅞″ thick, and in order to give a little better finished effect, the edge can be "quarter rounded" with a plane.

After taking the frame from the clamps, it is to be sandpapered thoroughly inside, the bottom then being placed in position, with the under side flush with the bottom of the rails all around. Then drive two 1 ½″ steel wire brads through the lower part of each rail into the edge of the bottom in order to hold the latter in place. The slots or receptacles must now be cut in the inside of the ends, or short rails, as shown in the illustration. This slot is 2″ long, ½″ deep, and ¼″ wide, and it starts 1″ from the inside face of the leg.

The figures given for the size of the top show an allowance of ⅜″ for an overlapping edge all around, so before marking out the location of the hinges, place the cover on the frame, making sure that the proper margin extends over the outside of the legs all around, then with a pencil, mark around the tops of the legs on the under side of the cover. This will determine the distance from the edge at which the hinges should be placed. The hinges should be attached first to the cover, and afterwards the cover should be attached to the tops of the legs as shown clearly in the illustration. The final work is a thorough sandpapering, first with No. 1, then with No. 0 sandpaper. When not in use, the foot-rest may be removed from the slots and placed in the bottom of the box. The finish may be as desired by the maker.

II. A MODEL STEAMBOAT.

CARL H. CLARK.

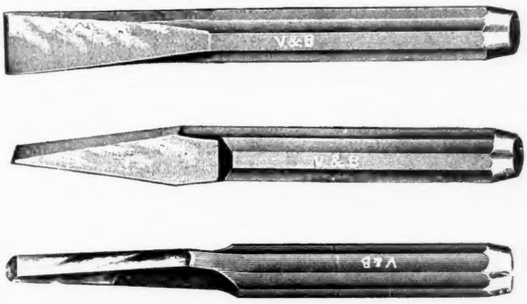
The Turbine described in the January number will serve very nicely to propel the steamer. Its position in the boat should be about on section No. 3. A small seating or foundation should be built for it to rest upon. To hold it in position small brass angle lugs are used. These are made by bending a strip of brass at a right angle and drilling a ¼″ hole in either leg. One of these may be slipped over each of the two lower bolts before inserting them, and another is put on under the nut on the other end. The other four holes may then be used to fasten the turbine in place.

The shaft hole should be bored ¼″ diameter and about 1 ⅜″ above the bottom of the keel. It runs horizontally and the seating is built up until the driving shaft is in the same line as the hole. For the shaft, a piece of 3-16″ steel rod is used, and is connected to the turbine shaft by a sleeve coupling. The after end of the shaft is filed down square for a length of about ⅝″. The last ½″ is again filed round, and a thread cut, which allows the propeller to put on the square part and a nut to be screwed up against it to keep it in place.

Some sort of stuffing box must be provided at the stern to prevent water running in around the shaft; all that is necessary, being an annular space filled only with packing and held in place. The propeller should be cast and filed up bright. It should be about 2 ½″ in diameter. The shape and proportions can best be gotten by seeing either a large propeller or some picture of one. The hole in the hub is worked out square to fit end of the shaft and a nut provided to hold it in place. The shaft is inserted from the inside and the propeller is put on. Connection is then made with the turbine. If necessary a bearing may be provided at about the middle of the length of the shaft to prevent its sagging. The exhaust pipe is ½″ diameter and is let up into the stack. The steam pipe from the boiler will be described in connection with the boiler in the next issue.

TOOLS AND THEIR USES.

COLD CHISELS are used for cutting metal. The more commonly used shapes are here illustrated. The *Flat* is used for wide cuts of no great depth. The *Cape* is used for narrow cuts, and in the hands of a skilled workman such accurate work as keyways in



FLAT, CAPE AND ROUND NOSE COLD CHISELS.

shafting can be done with this tool, a file being used for finishing. The *Round Nose* is used in corners, and where its shape makes it more desirable than the two previously mentioned. The chisel is held in the left hand, at the angle best suited to the cut, and given forcible blows with a machinist's hammer, the latter being made of hardened steel to prevent the face from becoming indented. Considerable practice is necessary before the worker can do efficient work with a cold chisel, and yet avoid mis-strokes with resulting damage to the knuckle of the forefinger.

COMPASSES, or as they are now more commonly termed DIVIDERS, are used to lay off circles, angles

and arcs;] to take measurements, and lay off the same on drawings or work. Also used as a "*Scriber*" to take of the line of a surface on work, one point following the line of the surface and the other marking the same on the work. The knurled handle projecting above the bow is of great assistance when striking circles, arcs, etc., giving ease of movement and an unobstructed view of the work. For large circles, arcs, etc., *Trammel Points* on a long beam are used. Crude points for such work can be made by putting pointed wire nails through a strip of thin wood, these serving where no great accuracy is required.

COTTERS are used for holding wheels, pulleys, and other parts of mechanism upon a shaft or similar bearing where a nut or other part has a tendency to work apart. Pins in moving joints are retained in position by cotters at the ends, these uses requiring a split cotter. In piston rods for pumps and engines, they are solid and serve to keep the parts of a bearing or joint in position.

COMPASS SAW, See *Saws*.

COUNTER-SINKS, are used in machines or bit brace for giving a V shape to the outer end of a hole in metal or wood to receive the head of a screw. The *Snail* countersink is used in wood; the *Rose* may be

used in either wood or metal, but for metal work that shaped similar to a diamond drill is preferable. When used in a machine the shanks are straight, and as each shape is made with shanks for either bit-brace or machine, when ordering by mail the method of use should be specified. A combination drill and countersink is a very handy tool when numerous holes for screws are to be made, the hole ready for the screw being made without being obliged to change tools.

CORRESPONDENCE.

No. 70. PHILADELPHIA, PA. Jan. 18, 1904.

I would like to know if you could give the approximate cost of building the sailboat described by Carl H. Clark in the Jan. '04, issue. Also, if a gasoline engine could be placed in the boat, as an auxiliary, without very great change in the boat.

G. G. M.

The cost of materials will vary with the locality; between $30 and $40 for the lumber, exclusive of spars. Metal work, about $10. Sails and rigging $15 to $25 according to quality.

A small engine could be installed by cutting away a piece of the deadwood aft, using a balanced rudder, and making water-tight around the shaft where it passes through the keel. The engine would have to be placed in the cabin, or extreme forward part of the standing room.

No. 71. SCHENECTADY, N. Y., Jan. 31, '04.

I would like to know if it is possible to obtain a set of castings for the model steam turbine described in the January number?

J. J.

No castings for this turbine are obtainable in this country, the description being of one made in England. Should a sufficient number of our readers make requests for these castings, they will be offered as a premium.

No. 72. BRIDGEPORT, CONN., Jan 30, '04.

I wish to know if there is any storage battery which will supply current to light six or seven incandescent lights in a satisfactory manner. If so, please tell me where to get them, and the chemicals for charging?

H. F. P.

Your inquiry does not state the size and voltage of the lamps you desire to use. If miniature lamps of 3 or 4 volts are intended, storage batteries are to be had which will do this nicely, of any large dealer in electrical supplies, but the expense for same will be considerable. They will also have to be charged by current from a dynamo, unless another set of cells of another type are obtained for charging, the latter being a rather unsatisfactory way. The Pullen cell manufactured by the Pullen Electric Co., Chestnut St. Philadelphia, Pa., is a cell which may be charged by chemicals, and recharged, when exhausted, in the same way. Twelve to fourteen of these cells would be required for the work above mentioned.

No. 73. PROVIDENCE, R. I. Jan. 30, '04.

Will you kindly inform me what the electrical resistance is of No. 23 guage German Silver wire per foot. Will you please tell me of some firms who make wood turning lathes?

P. H. F.

German silver wire varies considerably in the proportions of its constituents, and consequently the resistance would vary from the same cause. The resistance for 1000 feet, standard quality would be approximately 271.6 ohms. If great accuracy is required for some electrical instrument, the resistance should be obtained by testing with suitable instruments. These can be found at most electric light stations, and those in charge will usually render services of this kind if approached in a suitable manner.

Turning lathes are advertised in our advertising columns by several firms who will send catalogues upon request.

TRADE NOTES.

The attention of our readers is called to the advertisement of The Pike Manufacturing Co., on back cover of this issue. An item of special interest is their Hard Arkansas Stone for draftsmens' use. The Hard Arkansas Stone is quarried in the Ozark mountains, near Hot Springs, Arkansas. It is composed of pure silica, being a very hard stone of exceedingly sharp grit, and ranges in color from a milk white to a dark chocolate. Its extreme hardness may be better understood when we state that it is sixteen times as hard as common marble. Owing to this extreme hardness it is very difficult to work, and in its most perfect form is a very scarce article. The Pike Manufacturing Co., being owners of the best, and nearly the only quarries producing this stone, are in position to furnish the best obtainable, and their eighty years' experience in this line enables them to guarantee that their selection will prove satisfactory. They put up a small Arkansas Stone, about 2 x 1 x 1-4 inch which is a very convenient size for draftsman's use.

The Sawyer Tool Mfg. Co., Fitchburg, Mass., have just placed upon the market a new "Angle Indicator," which is a most excellent tool for those using anything of the kind. The graduations are very plainly marked, making readings easy and accurate. It can be used with any ordinary rule, straight edge or bevel. The edges are ground to 45 degrees and 90 degrees which gives it the additional value of a nice square, and makes it a very useful tool.

The American School of Correspondence, Chicago, Ill. announce the second edition of their book "Practical Lessons In Electricity," the first edition having been exhausted in a very short time. The new edition contains an additional section, and to cover the increased cost of publication, the price is now 90 cents.

The Franklin Dynamo manufactured by Parsell & Weed, 129 W. 31st St., N. Y. City, is an excellent machine for light work such as driving jeweller's lathes, sewing machines, etc. For those studying electricity, the making up of one of these dynamos would provide much information relative to principles covering same, A descriptive circular will be sent upon request.

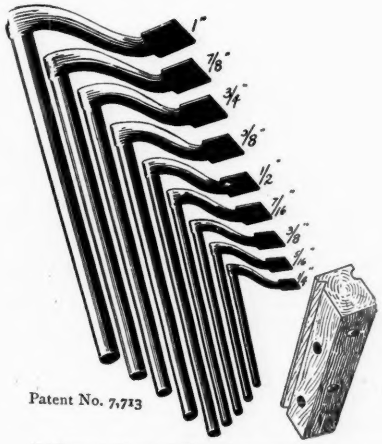
Anyone studying to become a mechanical or electrical engineer must of necessity acquire a reasonable proficiency in drafting. As the saving of time in this is very desirable, the use of the "Handy Drawing" outfit manufactured by J. & G. Rich, 120 N. 6th St., Philadelphia, Pa. will be found of exceptional value. The many desirable points in connection with this outfit cannot be fully appreciated without personal inspection, but the descriptive circular issued by the firm will convey a good general idea to those sending for it.

The efficiently of the telephone is largely dependent upon the transmitter. "The Workwell," manufactured by S. H. Couch Co., 154 Pearl St., Boston, Mass. is all that its name implies; well designed, well made, and sold at a low price. Just the thing for connecting house, stable, workshop, and different rooms in the dwelling.

Manual training schools are of necessity obliged to economise room to the best possible advantage. Where blacksmithing forms a part of the work, the blacksmith's rack manufactured by the New Britain Machine Co. New Britain, Conn., will be found a very valuable fitting for a work room, as on same a great number of tools and parts can be stored in an orderly and compact manner.

Parsell & Weed, 131 West 31st. St., New York City, have recently purchrsed the patterns for several new electrical and mechanical appliances, and a catalogue covering them is in preparation. An announcement will be made when it is ready, and readers of the magazine will find therein much to interest those following electrical and mechanical lines.

The Amateur woodworker who has never used a Seavey Mitre Box, manufactured by Smith & Hemenway Corp., 296 Broadway, New York, N. Y., has yet to learn the great advantages derived from its nse. Work, such as making tenons, mitering, moulding etc., can be quickly and accurately done with this box. The Model No. 5 would probably be most suitable for use by the readers of this magazine, but two other models are illustrated in their "Green Book."



Different Sizes of Clamp regularly carried in Stock

Another decidedly handy tool, made by the same firm, is the Vogt Vice Clamp which is one of the handiest tools of low cost to be found. It is a straight rod with one end curved and flattened in such a way that by driving the straight rod in side or top of the work bench, the work can be instantly and securely fastened and as readily released. Our readers are earnestly recommended to inquire for this handy tool of their hardware dealers and thus learn of its advantages.

Those proposing to make the magic lantern described in the last number of the magazine, should, whenit is possible to do so, visit Robey & French, 24 Bromfield St., Boston Mass. This well known firm carry a large line of photographic supplies and have special offers in projection lenses and condenses. An early visitor can secure exceptional bargains.

The Morse Twist Drill Machine Co., New Bedford, Mass., have issued a new catalogue which contains much of interest to teachers of manual training schools, and amateurs who do metal working and some branches of wood working. The excellent design and workmanship which charactcrizes the tools made by this firm is too well known to require special mention. Purchasers will find them in every way satisfactory. A copy of this catalogue will be mailed anyone interested, upon request.

A new illustrated catalogue of the North Bros. Mfg. Co. Philadelphia, Pa., has just been issued. This should be in the hands of every wood worker, whether amateur or professional, and will be mailed upon request. The excellent design and workmanship to be found in the tools manufactured by this company has virtually worked a revolution in the tool business of this class. No one can afford to waste time using old fashioned tools when these quick working tools can be had at such low cost.

The "Amateur" turning lathe is the most liberal premium ever offered in this country. You can easily get one if you will but make the trial.